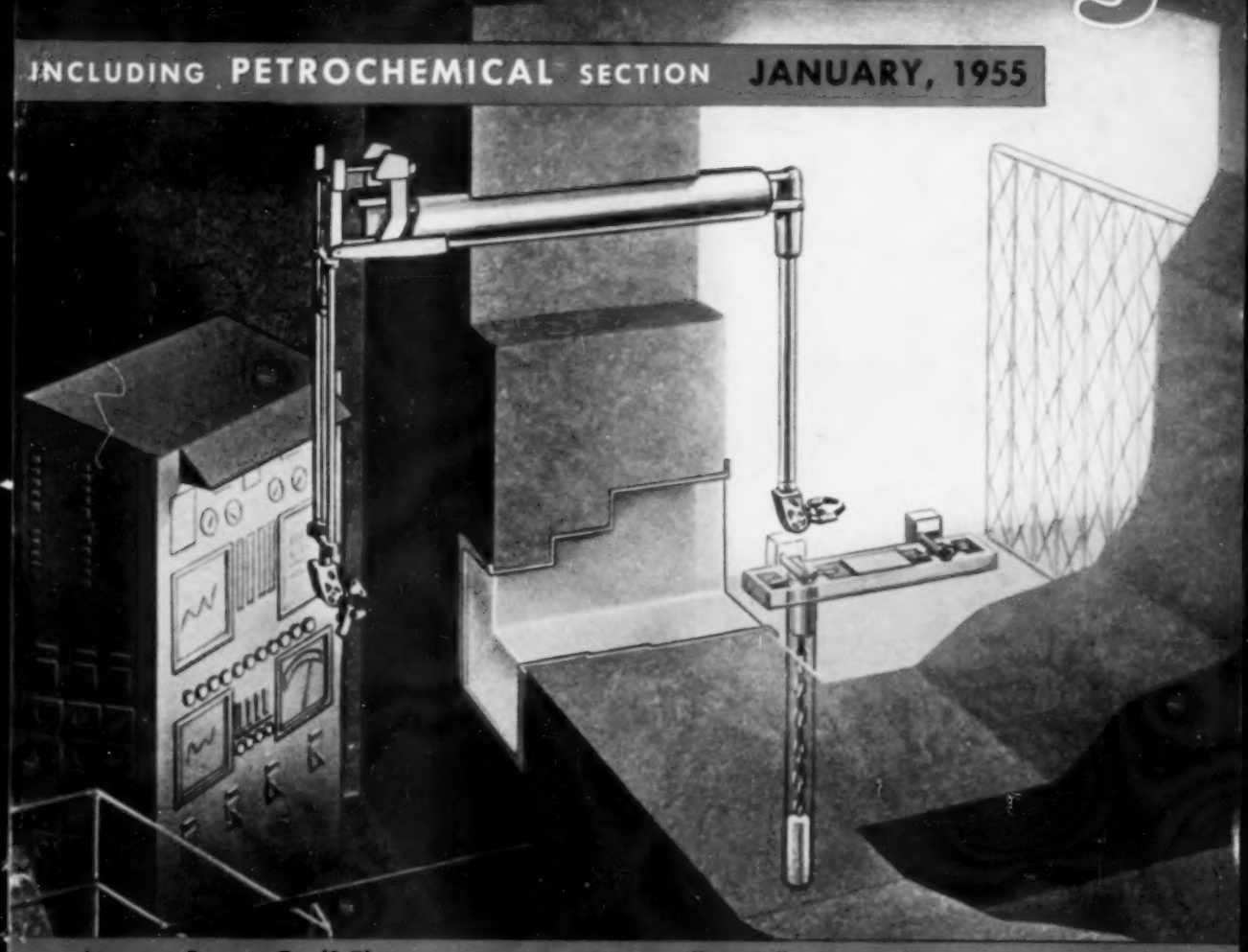
Petroleum Processing

INCLUDING PETROCHEMICAL SECTION JANUARY, 1955



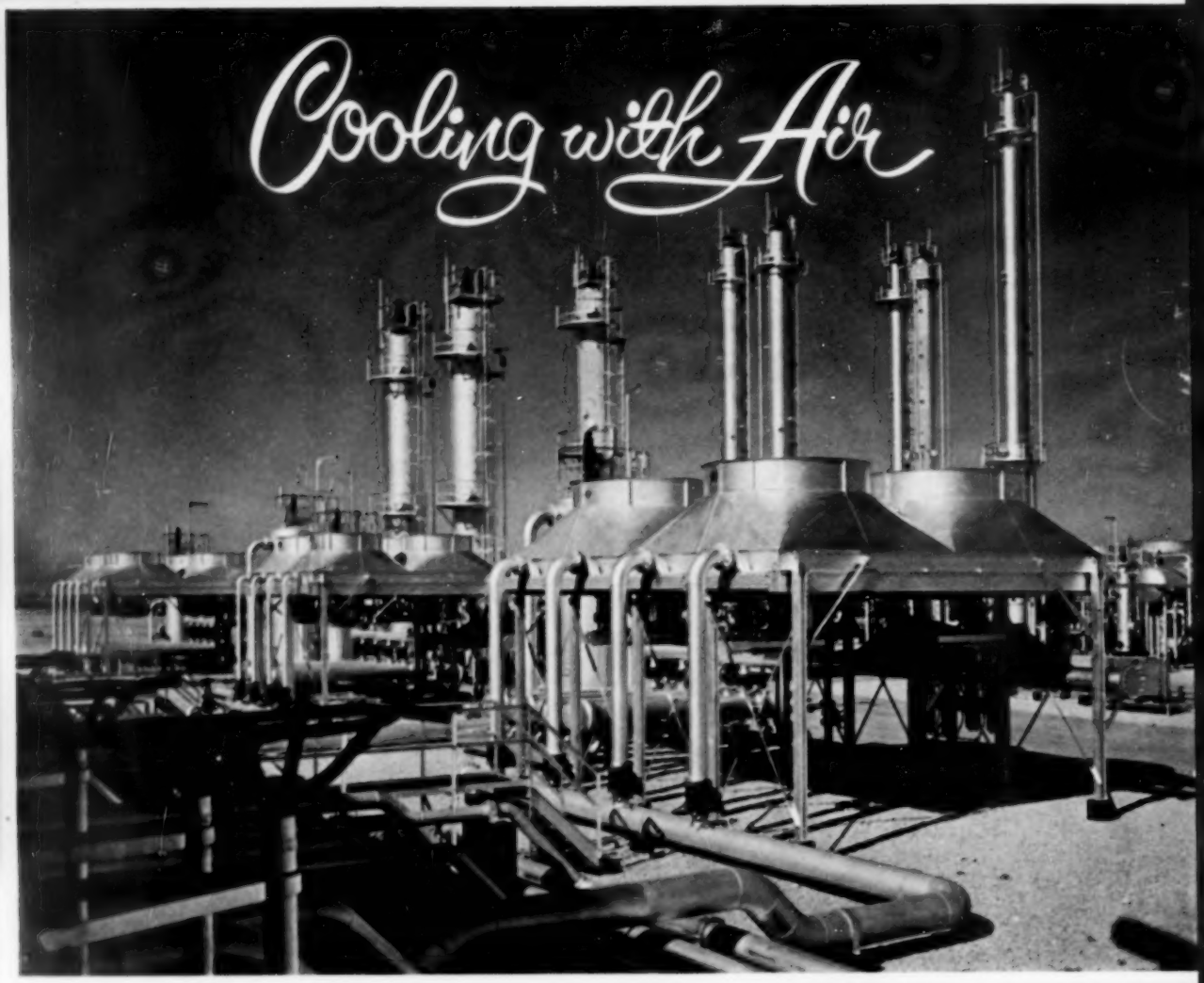
Atoms a Process Tool? The answer may cost one million dollars —p. 43

WANT GAS-FREE TANKS? — Here's a safe, one-hour method — p. 47

TOPS IN WHAT'S NEW — The best of last year's ideas — p. 54

WELDING PRESSURE METHODS — How to do it in the field — p. 56

A McGRAW-HILL PUBLICATION



HUDSON **SOLO-AIRE** units as pictured above are employed for dissipation of heat directly to air in rapidly expanding diversification of services. Almost every modern chemical plant, gas processing plant, or oil refinery, has cooling problems for which engineering comparisons dictate the use of Solo-aires for one or more services.

In water-scarce locations the choice of Solo-aires is obvious. Even where water is plentiful, careful comparisons of capital expenditures for cooling tower, piping, valving, water pumps, hot fluid to water exchangers, and costs of water treating, power and maintenance may result in selection of Solo-aires for direct cooling with air.

Where summer ambient air temperatures are too high to effect the required cooling with direct use of air, the HUDSON **COMBIN-AIRE**, in which air is first pre-cooled during warm weather, allows the advantages of air cooling with none of the disadvantages of ordinary cooling towers. Combin-aires are now constructed of fireproof materials, and as water spray is completely eliminated, they may be installed adjacent to process equipment.

Before proceeding with final design of process plant cooling systems let HUDSON assist you in making completely objective comparisons of water versus air cooling for all services.

New

Air cooled equipment bulletin mailed upon request

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

Enjay helps keep your sales out front

IN SURFACE COATINGS *(Paint and Varnish)*

IN PETROLEUM *(Lubricants and Gasoline Additives)*

IN CHEMICALS *(Synthetic Fabrics)*

Products that lead in sales are the products that deliver dependable quality and performance. And where quality and performance count, rely on Enjay. Enjay supplies the chemical, surface coating and petroleum industries with a complete line of uniform, high quality petroleum chemicals, backed by pioneering research, experience and proved results. Enjay is also ready to assist you in developing new or improved products through chemistry. Call Enjay *next* time for your chemical needs.

Enjay Company, Inc. • 15 West 51st Street, New York 19, N. Y.

PETROLEUM	SURFACE COATING	CHEMICAL
PARANOX	PETROHOL 91	PETROHOL 91
PARATONE	PETROHOL 95	PETROHOL 95
PARAFLOW	PETROHOL 99	PETROHOL 99
PARAPOID	JAYSOL	JAYSOL
PARADYNE	Secondary Butyl Alcohol	Iso-Octyl Alcohol
PARATAC	Secondary Butyl Acetate	Decyl Alcohol
PETROHOL	Isopropyl Acetate	Denatured Ethyl Alcohol
Methyl Ethyl Ketone	Acetone	Tridecyl Alcohol
Dewaxing Aid	Methyl Ethyl Ketone	Dicyclopentadiene
Ethyl Ether	Dicyclopentadiene	Isoprene
Isopropyl Ether	Ethyl Ether	Butadiene
Reference Fuels	Isopropyl Ether	Ethyl Ether
	Naphthenic Acids	Isopropyl Ether
	Iso-Octyl Alcohol	Tetrapropylene
	Decyl Alcohol	Tripropylene
	Denatured Ethyl Alcohol	Aromatic Tars
		Benzene
		Acetone
		Methyl Ethyl Ketone

ENJAY

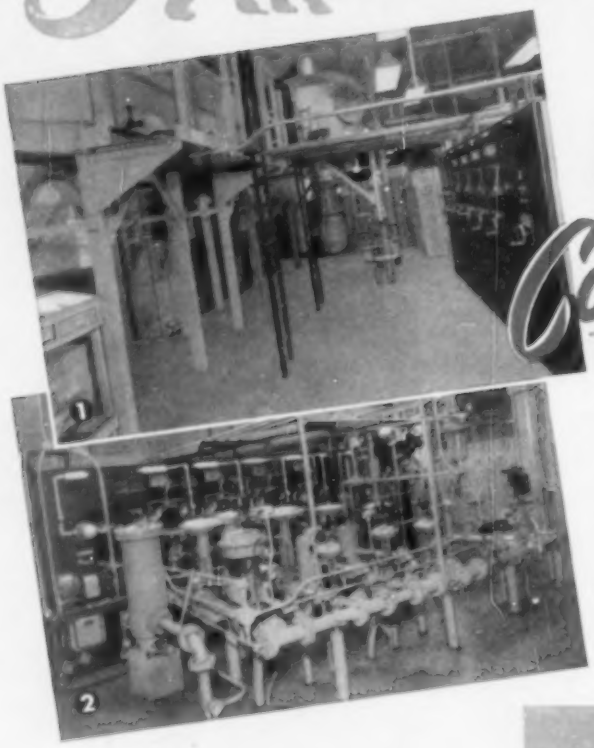
35 successful years of leadership in serving industry

(To obtain more data on advertised products see page 108)

SINCLAIR *INCREASES OUTPUT...*

...with % PROPORTIONEERS %

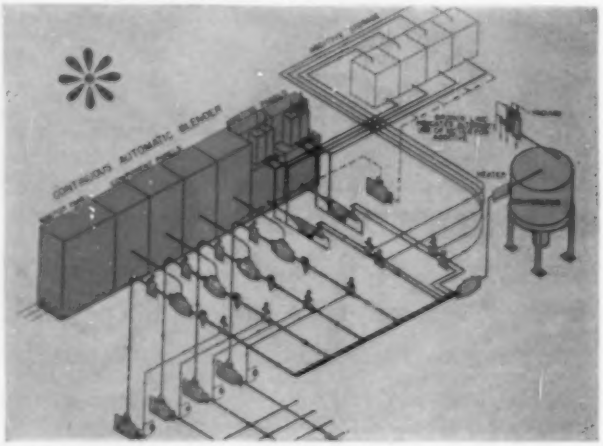
Automatic Compounding



This new %Proportioneers% installation at the Marcus Hook plant of Sinclair Refining Company utilizes phase control between components of lube stocks to reduce batch blending to completely automatic compounding. %Proportioneers% recirculation method permits exact presetting and control of component and additive ratios and allows quick adjustment of the total rate to production requirements without affecting these ratios. %Proportioneers% Continuous, Automatic Compounding makes possible greater flexibility between small and large quantity production with increased operating efficiency and new economies in material handling.

❶ %Proportioneers% compounding panels at right, additive storage upper left, and flash evaporator in background.

❷ Back side of compounding panels showing control valves, recirculation system, and blend manifold.



All equipment shown red in flowgram furnished by %Proportioneers, Inc.%

For complete information ask for Brochure SM-2055.
Write to Proportioneers, Inc., 447 Harris Ave., Providence 1, R. I.

PROPORTIONEERS

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • OMEGA MACHINE CO. • BUILDERS-PROVIDENCE, INC.

METERS FEEDERS CONTROLS

TECHNICAL SERVICE REPRESENTATIVES IN PRINCIPAL CITIES OF THE UNITED STATES, CANADA, MEXICO AND OTHER FOREIGN COUNTRIES

PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals.

January, 1955
Vol. 10, No. 1

Contents

FEATURE ARTICLES

Refining Section

Atomic Energy a Process Tool? 43
SOD will spend $1,000,000 in the next five years to find out, by William F. Bland

Want Gas-Free Storage Tanks? 47
You can have them in one hour by using this technique, by D. P. Thornton, Jr.

Unusual Features at Mandan 53
Process piping, roadbeds, and pumps are laid out for the greatest efficiency

Tops in What's New—1954 54
Brief repeats of the 'most interesting items reviewed in 1954's "What's New" section

Field Welding of Pressure Vessels 56
What to do and how to do it—before, during, and after the weld, by F. A. Upson

Heat Transfer Calculations 61
Here's a handy "step-wise" method for handling this kind of design problem, by Edward Grahl

Low Capacity Flow Control 70
Controlled volume pumps can do a job in many processing operations, by John Procopi

Petrochemical Section

Are You Thinking of Adsorption? 79
"Molecular Sieves" (synthetic zeolites) have opened up a new approach, a staff report

Predict Isothermal Enthalpy Changes 83
. . . for hydrocarbons with Berthelot's equation of state, by James H. Weber

DEPARTMENTS

Publisher's Page	5	New Words	83	Books	105
What's Happening	7	Plant Practices	87	Information Offered	106
Tomorrow	11	Patents	91	Advertisers' Index	108
Letters	15	Personals	95	What's New	109
Operating Trends	17	Suppliers	99	Editorials	140
News in Views	60	Meetings	103		

A McGRAW-HILL PUBLICATION

Member of Associated Business Publications and Audit Bureau of Circulations

Petroleum Processing is published monthly by McGraw-Hill Publishing Co., Inc. James H. McGraw (1860-1948) founder.

Publication Office: 330 West 42nd St., New York 36, N. Y.

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to **Petroleum Processing**, Subscription Service, 330 West 42nd St., New York 36, N. Y. Subscription rates: domestic single copies 35c, United States and possessions, $2 per year, $3 for two years, $4 for three years; Canada, $3 per year, $4 for two years, $5 for three years; Latin American and all other countries, $5 per year, $8 for two years, $10 for three years.

Published prior to Sept. 1946 as the Technical Section of National Petroleum News, devoted to Refinery Management and Petroleum Chemical Technology, and including International Petroleum Technology. Entered as second class matter March 17, 1954 at the Post office in New York, New York under the act of March 3, 1879. Printed in U.S.A. Copyright 1955 by McGraw-Hill Publishing Co., Inc. All rights reserved

WIGGINS DOUBLE PONTOON FLOATING ROOFS

Safest Storage for Your "Liquid Assets"

Performance records prove that Wiggins Double Pontoon Floating Roofs soon pay for themselves in liquid conserved. Only Wiggins Double Pontoon Floating Roofs have every important feature for maximum conservation . . . safest operation . . . low-cost maintenance.

Triple Seal increases conservation savings and adds extra safety.

Multiple gas-tight pontoon compartments increase safety, strength and buoyancy.

Simplified design gives strength with minimum trussing, making inspection and maintenance easy.

Complete, clean drainage reduces corrosion problems.

Get the full story on the General American-Wiggins system of petroleum liquid conservation by writing us on your letterhead for the new Wiggins Manual WP-14.

Wiggins Double Pontoon Floating Roofs, Dry Seal Gasholders, Lifter Roofs, Cone Roofs

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 SOUTH LA SALLE STREET · CHICAGO 90, ILLINOIS

A McGRAW-HILL PUBLICATION

Editorial & Business Offices
330 West 42nd St., New York 36, N.Y.

Harry L. Waddell, Publisher

Editorial Staff

William F. Bland, Editor
William C. Uhl, Managing Editor
Virgil B. Guthrie, Associate Editor
Robert L. Davidson, Assistant Editor
William A. Caperell, Jr., Art Director
Stuart D. Boynton, Editorial Assistant
Jane L. Witzig, Editorial Assistant
D. P. Thornton, Jr., Southwestern Editor
810 First Nat'l. Bank Bldg., Houston 2
Don Sweeney, West Coast Editor
1111 Wilshire Blvd., Los Angeles 17
Andrew R. Patla, Washington Editor
1188 Nat'l. Press Bldg., Washington 4
Peter J. Gaylor, Patent Reviewer

Business Staff

K. W. McKinley, Advertising Sales Mgr.
John E. Thompson, Production Mgr.

Regional Sales Representatives

NEW YORK 36, N. Y.
Fred R. Emerson, 330 West 42nd St.
Walter W. Patten, 330 West 42nd St.
PHILADELPHIA 3, PA.
C. J. Jefferis, 17th and Sansom Sts.
ATLANTA 3, GA.
S. T. Henry, 801 Rhodes-Haverty Bldg.
CLEVELAND 15, OHIO
William R. Freeman, 1510 Hanna Bldg.
CHICAGO 11, ILL.
Robert W. Bruley, 520 N. Michigan Ave.
HOUSTON 2, TEXAS
George Reid, 810 First Nat'l Bank Bldg.
SAN FRANCISCO 4, CALIF.
Ralph Dorland, 68 Post St.
LOS ANGELES 17, CALIF.
Joseph Allen, 1111 Wilshire Blvd.

Batting Averages, Covers, and Indexes

ONE of the services to which we have access as a McGraw-Hill publication is the company's Department of Economics—which regularly provides us with predictions as to what's ahead in the economic and business climate. You seldom see these predictions as such, because we usually use them as background information or rewrite them to fit our own particular requirements. But they are with us, just the same.

It was rather comforting, therefore, to learn from a recent report from Dex Keezer, director of the department, that during the past two and a half years his group's predictions have shown a batting average of 0.816. Out of 114 specific forecasts made during that period, 93 of them proved to be exactly right as stated, and the remaining 21 were not quite so accurate. Looks like we should be paying even more attention to what Dex says—and so to start the year off properly, here is what he sees for '55:

In general: "The upturn in business now in progress in the U.S. will be well maintained through 1955. Some sogginess will develop toward the end of the year but it will be relatively transitory."

* * *

You've probably noticed the new front cover design on this issue. It was worked out by our art director, Bill Caperell, with much sideline coaching from the entire staff and a few outsiders.

When Bill was asked to revamp the cover he was given three specifications to follow: (1) redo the lettering of the publication name to make it more legible, but (2) at the same time retain the character of the former lettering so the change wouldn't be too much of a shock to you, our readers, and (3) get more "excitement" into the cover. Looks to me like he has done a good job on all three counts.

While he was at it, Bill put a few deft touches on the "backbone" or spine of the cover so that you'll be able to pick out a particular issue from a stack of copies more quickly.

* * *

One last matter. We've compiled our annual author and subject index for the 1954 issues of PETROLEUM PROCESSING. You can have your copy—no charge, of course, simply by sending us one of the Reader's Service cards you'll find between pages 108 and 109 of this issue. Circle No. 40 on the card, fill in your name and address, and drop the card in the nearest mailbox. No postage required in the U.S.

And while you're at it, why not use that card to request more information on any of the items reviewed this month in our annual "Tops in What's New" (pp. 54-55).

William F. Bland

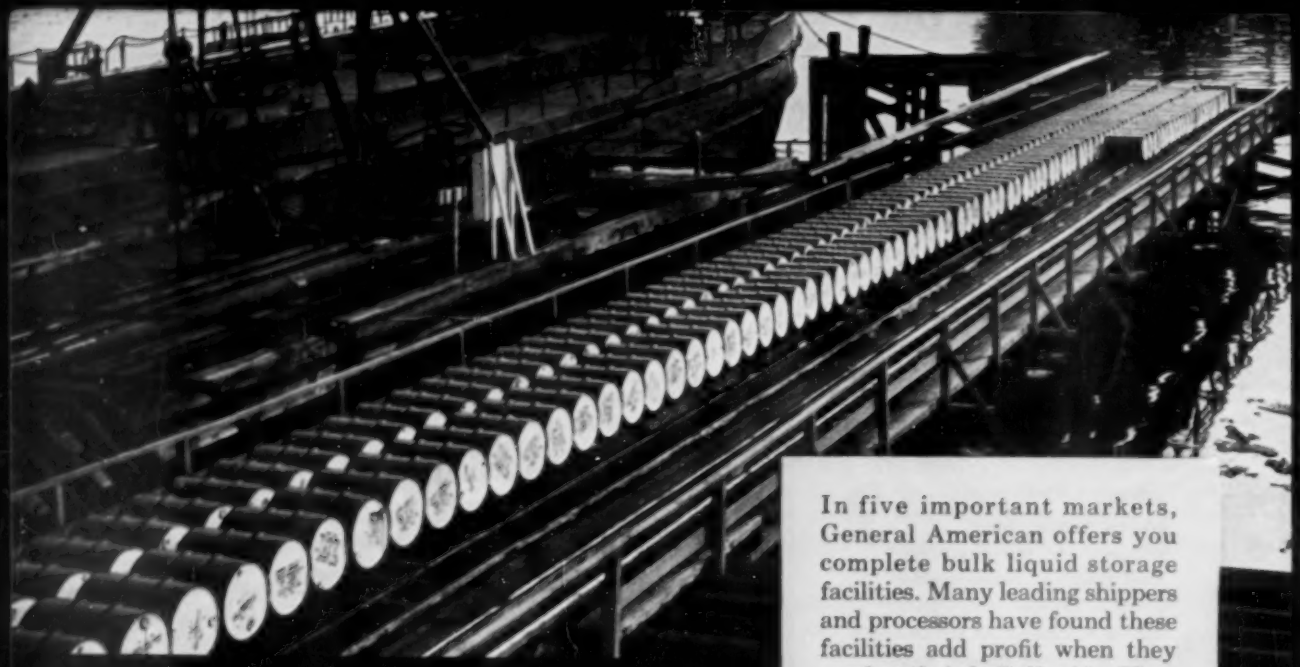
Editor

Other McGraw-Hill Petroleum Publications

National Petroleum News
The monthly oil marketing magazine, covering news, prices, transportation, storage, merchandising.

Platt's Oilgram News Service
A daily independent oil-news reporting service issued from New York, Chicago and Houston.

Platt's Oilgram Price Service
A daily independent oil-price reporting service issued from New York, Chicago and Houston.



Store and Distribute

your bulk liquids as the market demands— with no capital investment

GENERAL AMERICAN TANK STORAGE TERMINALS

a division of GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street · Chicago 90, Illinois

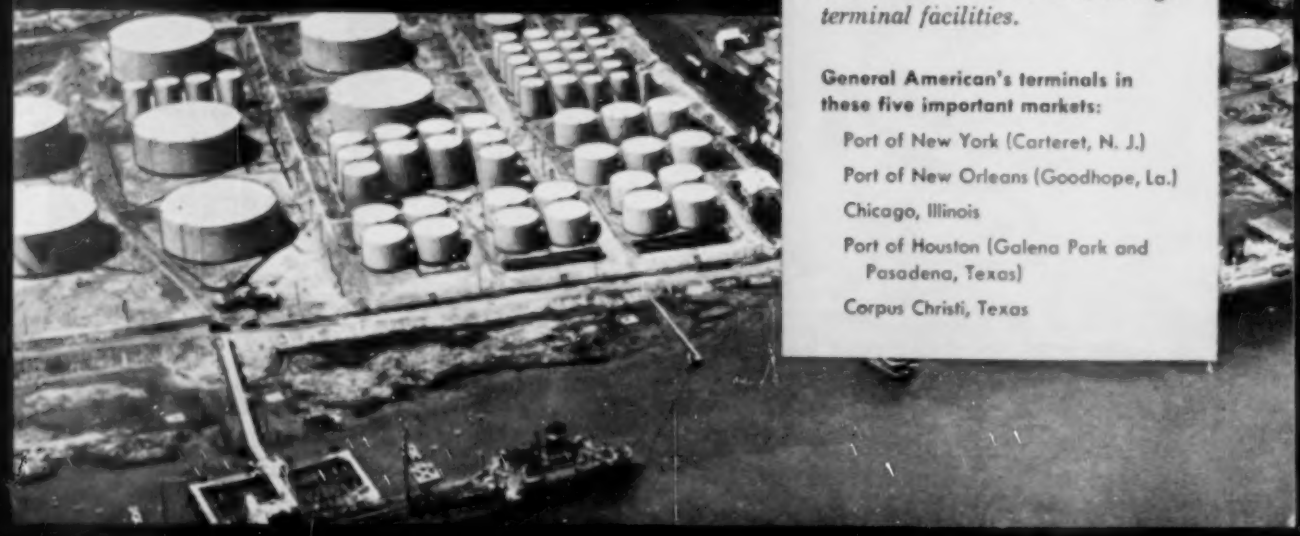
In five important markets, General American offers you complete bulk liquid storage facilities. Many leading shippers and processors have found these facilities add profit when they market their bulk liquids. They can maintain inventories of their products for distribution at the right time and place; gain economies of shipping in bulk; and *conserve* capital.

Modern storage tanks . . . for anything that flows through a pipeline . . . are yours to use. You can be sure of privacy. Carefully guarded manifolds, pipes and pumps to protect your product against contamination. Barrelling, drumming, canning and blending services at New York, New Orleans and Chicago. All this, without capital investment on your part!

Ask about the marketing advantages you receive from leasing General American's tank storage terminal facilities.

General American's terminals in these five important markets:

- Port of New York (Carteret, N. J.)
- Port of New Orleans (Goodhope, La.)
- Chicago, Illinois
- Port of Houston (Galena Park and Pasadena, Texas)
- Corpus Christi, Texas



What's Happening

in Refining

. . . **Plans for first complete refinery in Hawaii** have been announced by Standard Oil Co. of California. A plant of between 20,000 and 30,000 b/d capacity is to be built in near future on an as yet undetermined site in Honolulu at an estimated cost of $25 to $30 million. Products will be two grades of gasoline, Diesel fuel, and fuel oil, company said.

Only existing refinery in the Islands is 3000 b/d skimming and asphalt plant of Pacific Refiners Ltd. Main suppliers are California Standard, Shell, Tide Water Associated, and Union Oil. Industry estimates of Hawaiian demand during first half of 1954 were about 29,000 b/d. Taxable gasoline sales have been averaging 9000 b/d in recent months.

. . . **Imperial Oil Ltd.** has awarded a contract for the cat poly unit and naphtha fractionator at its Ioco, Brit. Col., refinery to Canadian Bechtel Ltd. Completion of the units is scheduled for Sept.

. . . **Two proposals for a refinery in Arizona** have come to light, chiefly because of central Arizona residents becoming agog over smog. The Phoenix area is subject to atmospheric conditions similar to the Los Angeles basin. One proposal, reported to be backed principally by Bankers Life & Casualty Co. of Chicago, is for a plant at Florence, 60 miles from Phoenix. The other proposal, on which little information has been disclosed, would locate a plant in Phoenix.

. . . **New construction projects** approved for fast tax write-offs recently include the following:

Sinclair Refining Co., $3,252,000 for expansion and revision of catalytic cracking unit and gas plant at East Chicago, Indiana.

Esso Standard Oil Co., $612,000 for two 25,000 b/d crude desalting units at Everett, Mass.

Frontier Refining Co., $1,500,000 for 2000 b/d catalytic reformer, 3000 b/d desulfurization unit, and six storage tanks (total capacity, 155,000 bbl), at Cheyenne, Wyo.

Great Southern Chemical Corp., $94,000 for installation of additional hydrogen compressor on existing platinum type catalytic reformer at Corpus Christi, Texas.

Salt Lake Refining Co., $185,000 for additional steam generation facilities at Salt Lake City, Utah.

Humble Oil & Refining Co., $236,500 for additional facilities on alkylation unit at Baytown, Texas.

Honolulu Oil Corp., $1,104,500 for natural gasoline plant to process 6,500,000 cfd of gas and produce 1210 b/d of LPG products in Nolan County, Texas, plus gas gathering system.

Magnolia Petroleum Co., $119,500 for additional compressing and stabilizing facilities at Hurricane Creek natural gasoline plant, Beauregard Parish, La.

Stanolind Oil & Gas Co. (as operator), $209,000 for additional compression and auxiliary facilities at the North Cowden natural gasoline plant, Ector County, Texas.

Cleveland Gasoline Co., $136,000 for natural gas liquids processing facilities, gathering and transmission lines, near Norman, Okla.

Goliad Corp., $4,081,750 for a natural gasoline plant to process 188,000,000 cfd of gas, in San Patricio County, Texas.

Cities Service Oil Co. (as operator), $6,843,000 for a natural gasoline plant to process 45,000,000 cfd of natural gas into LPG and natural gasoline, in Midland County, Texas.

Phillips Petroleum Co., $487,000 for additional facilities at natural gasoline plant in Upton County, Texas.

. . . **Output of new Wrenshall, Minn., refinery** of International Refineries, Inc., (10,000 b/d) will be marketed by two Minneapolis private-brand distributors, Western Oil and Fuel Co. and Direct Service Oil Co., who have "substantial" interest in International and who have just completed merger arrangements. Together, they have over 250 retail outlets in Minnesota, the Dakotas, Wisconsin, Iowa, and in Canada.

. . . **McCallen Refining Co.,** Huntington Beach, Calif, has shut down its 6000 b/d skimming plant temporarily but will "try to stay open somehow" over the long pull.

in Petrochemicals

. . . **Pipeline movement of butadiene** fromTexas to the synthetic rubber plants in Akron, Ohio, is being talked about again by some of the rubber companies. Gasoline would be used as a carrying vehicle in existing product lines. Although still in the talk stage, such movement of light materials (which wouldn't necessarily be limited to butadiene) could mean more petrochemical plants nearer to consumer markets.

. . . **Shell Oil Co.** has obtained a fast tax write-off approval on 40% of an expected $192,000 investment in facilities for transferring glycerine and epichlorohydrin from Shell Chemical Corp. plant and its marine loading and unloading docks at Houston (Deer Park), Texas. Deleted from the write-off but listed as part of the cost is an additional $73,000.

. . . **Lynn Carbon Black Co.** plans a full-scale carbon black plant in the San Angelo, Texas, area, for research and development work on its "Furmatic" process. Exact location and capacity have not been determined.

Consolidated Carbon Corp. of Chicago has world rights to manufacture carbon black by the new method in other than the experimental unit. Consolidated has

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

located sites for five such plants: two in Louisiana, and one each in No. Dakota, Wyoming, and Canada; and has plans for five more.

Output from San Angelo is planned to be sent to a new fertilizer plant Consolidated is building in Chicago. This plant will produce a pelleted, organic fertilizer containing 12% carbon black.

. . . **Dow Chemical Co.** has purchased Versenes Inc., a Framingham, Mass., manufacturer of chemical specialties used in such fields as detergents, soaps, textiles, rubber, petroleum, and related industries, and known as chelating agents.

. . . **Goodrich-Gulf Chemicals, Inc.,** reports it has succeeded in reproducing the true molecule of crude, natural rubber. Patents have been applied for. Company states different materials are used than those to make GR-S and the rubber could not be produced in presently existing government-owned synthetic rubber plants. Best price estimates put it at considerably higher than GR-S' 23¢/lb.

. . . **"ANIC",** a group of petroleum companies controlled by the Italian government (Ente Nazionale Idrocarburi), has started construction of a $75,000,000 plant at Ravenna for producing synthetic rubber and nitrogenous fertilizers from methane (natural) gas, available from wells near the plant site.

Potential output, expected to be attained in three years, is 30,000 ton/yr. of the rubber—which is to be sold at about 25¢/lb (U. S. home price is about 23). Fertilizer production will be about 350,000 ton/yr. Gas processed is expected to be about 14 billion cu. ft. per year.

. . . **Shell Petroleum Co. Ltd.** is nearing completion of a plant for producing epoxy resins at Stanlow, England. Operations are expected to begin early this year and output will be about 1000 ton/yr.

in Markets and Prices

. . . **Markets for refined products** had a healthy glow at mid-December. Cold weather kept demand for both light and heavy fuels strong. And prices remained buoyant following increases in several of the principal primary supply markets.

Gasoline also staged a comeback in territory served by the Great Lakes Pipe Line—from Kansas to the Canadian border—when shortages developed at many terminal points. Discounts (from quoted prices) were cut in half.

The switch was due to unusually heavy Fall plowing that boosted consumption in this area as much as 100% over estimates of some district sales offices.

. . . **A good season for all grades of fuel oil** and an improved Spring market for gasoline was the outlook as seen by refiners at mid-month. General optimism was based upon expectations that a winter favorable to fuel oils is ahead and that rising prices for home heating and industrial oils will mean maximized fuel oil yields with gasoline production held down. Adding to the brighter outlook was the fact that refinery runs had been held below 85% of capacity.

. . . **A hike of 0.25¢/gal in distillate fuels** at the Gulf Coast and rising tanker rates boosted light fuel prices 0.3 to 0.6¢ along the eastern seaboard.

Heavy fuels went up 7 to 16¢/bbl. at Atlantic Coast ports, due mainly to strong markets and higher rates for dirty bottoms. Increases in distillates at the Gulf also boosted prices at inland water terminals. And cold weather in north central states brought "premiums" of as much as 0.25¢/gal (over Group 3 low, plus pipe line tariff) for "pipe line" distillates.

. . . **Continued heavy demand** for mid-Continent residual brought a 5¢ advance, to $1.40/bbl., in Group 3 price for No. 6 fuel. Traders were predicting that No. 6 price will reach $1.50, Group 3, by midwinter.

in Foreign Operations

. . . **The Johnson Line,** a large Stockholm shipping company, will soon begin construction of a refinery at Gothenburg, with an approximate capacity in its initial stages of 2600 b/d. Facilities will include: atmospheric and vacuum stills, and asphalt oxidation. Light products will be further refined at the company's existing refinery at Nynashamn, south of Stockholm.

. . . **Esso Refinadora Petroleo S. A.** will build a new lubricating oil plant at Buenos Aires, Argentine, of approximately 10,000 b/d capacity, utilizing a solvent extraction process. Cost and time schedule for completion were not disclosed.

in Labor and Transition

. . . **A no-raise agreement featured the union contract** for one year signed at Standard Oil Co. (Ohio) No. 1 refinery in Cleveland. It is first time since end of World War II such an agreement was made by the 600 employes, whose bargaining agent was Local 395 of the Oil Workers International Union.

. . . **Professional unionization failed** in bargaining election at Cities Service Refining Corp., Lake Charles, La., in which professional and technical employes turned down American Federation of Technical Engineers (AFL) representation by a 45-29 vote. The results have been certified by the National Labor Relations Board.

. . . **Eventual extension of Western Canada crude line** to Montreal must come and is real key to oil self-sufficiency for Canada, according to J. G. Godsoe, vice president of British American Oil Co. Line now brings crude from prairie provinces to Sarnia. Montreal area refining, 178,000 b/d and a third of Canada's total, still operates largely on imports.

LUMMUS

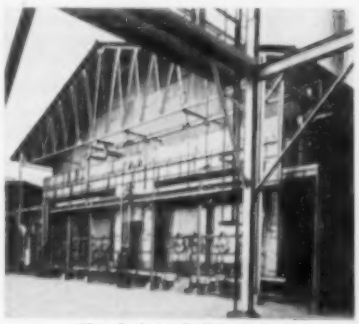
DIVERSIFIED TO BUILD OR EQUIP PETROLEUM, CHEMICAL AND POWER PLANTS

Engineering and construction of chemical and petrochemical plants

Engineering and construction of petroleum refineries

Manufacture of heat transfer equipment
(Heat Exchanger Division)

Shop fabrication and installation of pressure piping
(Fabricated Piping Division)

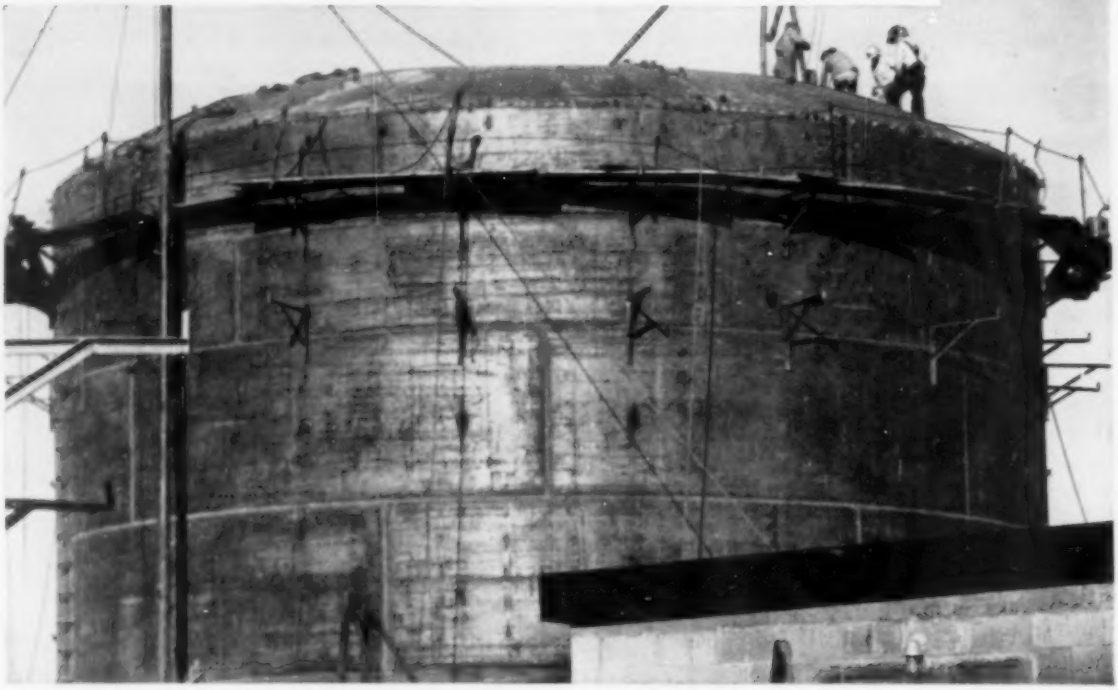


Manufacture of oil heaters
(Oil Heater Division)

In the past 50 years, Lummus has designed, engineered and constructed over 700 major plants and installations throughout the world. We would be pleased to work with you on your next project.

The Lummus Company, 385 Madison Avenue, New York 17, N. Y. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana.

GRAVER ...pioneer in FIELD ERECTION IN ALLOYS

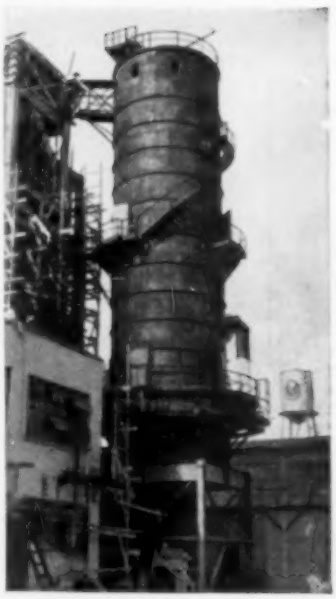


When Seeking a Source...

Consider the wealth of experience Graver has gained in field erection in alloys . . . experience that dates from the birth of alloys. It is standard procedure for Graver to build large, site-erected tanks, towers and process vessels of every size and description—like the large nickel-clad tank for storing caustic shown above, and the intricate spray tower on the right.

Both in this country and abroad, Graver has acquired a reputation for fine craftsmanship, plus a unique ability to more than satisfy customer demands.

For all industries—chemical, petroleum, food, pharmaceutical—Graver fabricates in nickel, stainless, clads and aluminum, as well as in carbon steels. Precision work, painstaking care, intensive inspection methods—these are integral parts of the Graver method. Taken together, they mark Graver as a source worthy of your consideration.



GRAVER TANK & MFG. CO., INC.

East Chicago, Indiana

CHICAGO • NEW YORK • PHILADELPHIA • EDGE MOOR, DEL. • ATLANTA • CATASAUQUA, PA. • PITTSBURGH • CLEVELAND • DETROIT • TULSA • SAND SPRINGS, OKLA. • HOUSTON • ODESSA, TEXAS • CASPER, WYO. • LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

Will the "Quantum Jump" Replace Petroleum Processing Plants?

SUPPOSE you could drive a car 15,000 miles on a pint of gasoline? If retired Army Col. Harry Hardsog's "quantum jump" scheme for an 8000-fold boost in usable energy from coal, oil and carbonaceous fuels works, it might be possible. Fairchild Engine & Airplane Corp. sees some possibilities in it and has negotiated to establish Hardsog in a laboratory at Northboro, Mass. to develop his theory.

Carbon atom excitation, a type of atomic fission not tried before, is the basis for the process. Excitation upsets the energy balance within the atom, releasing energy in the form of heat, temperature and pressure. The fission might be the form in which excited carbon breaks into one hydrogen atom, one boron atom and 16 million electron volts of energy. The products would *not* be radioactive and one pound of carbon would release 55,900,000,000 Btu.

Tests have been conducted using both bituminous coal and insulating tar—the latter accidentally. Calorimeters were destroyed by the energy produced from 0.001 gram of coal, and 2 or 3 lb. of insulating tar produced an explosion that completely destroyed a frame laboratory building.

Military interest has been captured by the fantastic possibilities of the "quantum jump". One government agency stated that though not completely tested, the invention has a reasonable chance of successful operation.

This may be the invention of the century, or it may be simply an inventor's dream. Anyway don't rush out and sell your storage tanks. Conventional gasoline is good for a few more years. —R.L.D.

Knock Reaction Studies Give New Clues to Motor Fuel Quality

THE automotive and petroleum processing technologists have learned a great deal about combustion knock in the past several years; and the application of their findings has resulted in increased power and performance for automobile engines.

Research by du Pont [1] in the chemical reactions causing knock throws additional light on the subject and may eventually provide refiners with the knowledge to improve still further the ability of their gasolines to suppress engine knocking.

"Up until the last few years," it is reported, "the physical nature of knock and the factors affecting it had been explored, but only a few glimpses into the actual chemical reactions causing knock had been obtained. It is only recently that techniques have been improved, instrumentation refined, and the knowledge of rapid chemical chain reactions developed to the point which has allowed real progress to be made in the study of the chemical reactions occurring in engines. As a result of these recent chemical studies, the picture of the changes which occur in the fuel-air mixture in an engine prior to combustion, the effect of these changes on knock and the method by which antiknock functions has become more clear."

Special work was carried on in the du Pont laboratories to determine the presence of fuel oxidation products prior to autoignition. "Although hydrocarbon oxidation preceding combustion in an engine is a very complex reaction," the report goes on, "the essential features appear to be the formation and decomposition of organic peroxides, and the reactions of their decomposition products to form hydrogen peroxide, formaldehyde and radicals having high amounts of energy."

The hydrocarbon type plays an important part in these reactions, it was shown. "Although the knock reaction may be a rather simple one consisting of extremely rapid production and combination of hydrogen and oxygen containing species, the formation of the critical concentrations of these species necessary to trigger the reaction is dependent upon the structure of the hydrocarbon or other fuel being burned in the engine."

An example is given of the effect of the hydrocarbon type. "In general, olefins blend with paraffins to give higher octane numbers than would be predicted from the octane numbers of the two components. It has been seen that olefins inhibit their own oxidation. They also act to inhibit the oxidation of paraffins with which they are blended. Addition of diisobutylene to n-heptane, for example, raises the engine compression ratios at which oxidation of the heptane is initiated and at which a cool flame appears, and slows the cool flame reaction so that considerably more severe engine conditions are required to produce autoignition."

New information on the reactions leading to knock, such as is reported here, points the way toward better understanding of improved methods for controlling abnormal combustion in engines, either by changes in the type of fuels the refiners turn out or in new engine design. —V.B.G.

(1) "Some Concepts of Knock and Antiknock Action," B. M. Sturgis, Petroleum Laboratory, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., before National West Coast Meeting, Society of Automotive Engineers, Los Angeles, Aug. 16-18 1954.

Future Oil Measurement Methods — As Seen by an API Task Group

WHAT if all volume measurements in the refinery—from crude charge to products shipped—could be handled without men doing gaging, calculating from orifice meter charts and watching meters print tickets at loading racks? Suppose most of the so-called inspection tests also could be made without taking the product out of the line?

Suppose all this information could be determined automatically at the several locations, converted into electrical impulses and fed to central control panels? There, a few men could break it down and perhaps re-direct it to the proper departments—for instance, accounting and the like.

Much lost time and motion could be saved. There would be less hazard of falls on icy tank ladders and fewer "guesstimates" in bad weather. Accuracy should certainly be improved and information made available faster.

This is not a "Buck Rogers" fantasy of the far future. This is what an American Petroleum Institute task committee[1] suggested as a possibility when asked to consider what future oil measurements might be liked. They pointed out that oil demand in 1975 will be about 65% greater than it is now; which is about 5 million bbls more than now being run to stills.

As an answer to: "What will we keep it in?" they postulated the possibility of a non-stop system from well to service station. Very possibly, this would utilize the existing storage systems as a "surge capacity." If the present system isn't streamlined in some way, that 65% boost in throughout will require a corresponding stiff boost in tankage, adding to investment costs.

The committee stated that: "There is no apparent reason why the entire measurement operation in both crude oil and refined products cannot be made wholly automatic, including the determination of net quantities, calculation of loss data, recording of inventory-control statistics, compilation of yield information, and other important end uses of the actual measurement."

They envisioned that the ultimate result would be "the immediate preparation and availability of financial statements and other operating statistical reports" so important to management.

These accomplishments are not nearly so remote as some may think. Many different and new devices—based on electronics, radioactivity, teletype, radio and others—already on the market today will make possible many newer concepts of measurement—even in the very near future. —D. P. T.

(1) "A Glance into Bulk Oil Measurement of the Future," a group paper presented by J. H. McClintock, Esso Standard Oil Co., at 34th Annual Meeting, American Petroleum Institute, Nov. 8, 1954, Chicago, Ill.

West Germany's Petrochemicals—Still Small, but Rising Steadily

INDUSTRIALISTS in Hamburg see good progress in the next few years for the production of petrochemicals in West Germany, owing chiefly to the increasing availability of refinery and natural gases.

They say that only during the past year has it been possible to start building up production of petrochemicals and to sell these products at competitive prices—that is, since duty-free imports of crude oil and oil products for the manufacture of chemicals were permitted.

What is the present petrochemical production in West Germany? Naphthenic acids are being produced by the Deurag-Nerag refineries near Hanover, and by the German Shell organization, the Wintershall Oil Co., and the Gelwerke Julius Schindler, all at Hamburg.

The Rheinpreussen Co. in the Ruhr is using refinery gas from the Wesseling hydrogenation plant, the BP refinery (Anglo-Iranian) and the Deurag refinery for the manufacture of isopropyl alcohol, butyl alcohol, and alkyl benzol by a modified sulfuric acid processing method. Present production of alcohols is about 3500 ton/yr. and that of alkyl benzol about 2000 ton/yr.

The Chemische Werke Huels, near Duesseldorf, is processing annually about 300,000,000 cubic meters (approx. 11,000,000,000 cu. ft.) of natural gas from the Emsland oil fields, refinery gas from the Gelsenberg and Scholven hydrogenation plants, and about 12,000 tons of butane from the Deutsche Vacuum refineries near Bremen, and the BP plants.

Acetylene, ethylene, and propylene are Huels' products, made by the electric-arc method. These, in turn, are used to make synthetic rubber, plastics, solvents, etc. Recently a test project has been set up for pilot plant work on aromatics.

Phenol production began recently at Zweckel, Westphalia, by the Phenolchemie GmbH, using a so-called "Cumole" process. Benzene and propylene, the raw materials, come from the Scholven hydrogenation plant. Output is estimated at about 8000 ton/yr. of the phenol, with about 5000 tons of acetone as a by-product.

The Cumole process was licensed for use from the British firm, Distillers Co. Ltd. who, in cooperation with Hercules Powder Co., had developed it from an original method invented by a Prof. Hock. Phenolchemie GmbH is also using new procedures developed in the laboratories of a parent firm, Bergwerksgesellschaft Hibernia A.G., for the oxidation of isopropyl benzol and the splitting of its hydroperoxide.

Phenolchemie is a new German company, founded in May, 1952. Equal shares of the firm are owned by the following: Bergwerksgesellschaft Hibernia A. G., located at Herne; Ruetgerswerke A. G., Frankfurt; Scholven-Chemie, Gelsenkirchen-Buer; and Harpener Bergbau-Aktien-Gesellschaft, Dortmund.

Several other companies have plants still under construction. The Rheinische Olefinwerke at Wesseling, in the Ruhr valley, will process refinery gases to produce ultimately and primarily polyethylene and smaller quantities of ethyl benzol. Completion is expected by sometime in 1955. The Ruhrbau GmbH, owned 50% by Farbenfabriken Bayer at Leverkusen, plans to establish a plant for making ethylene. Still another company, Knapsack-Griesheim A.G., Frankfurt, plans to use propylene to produce isopropyl alcohol.

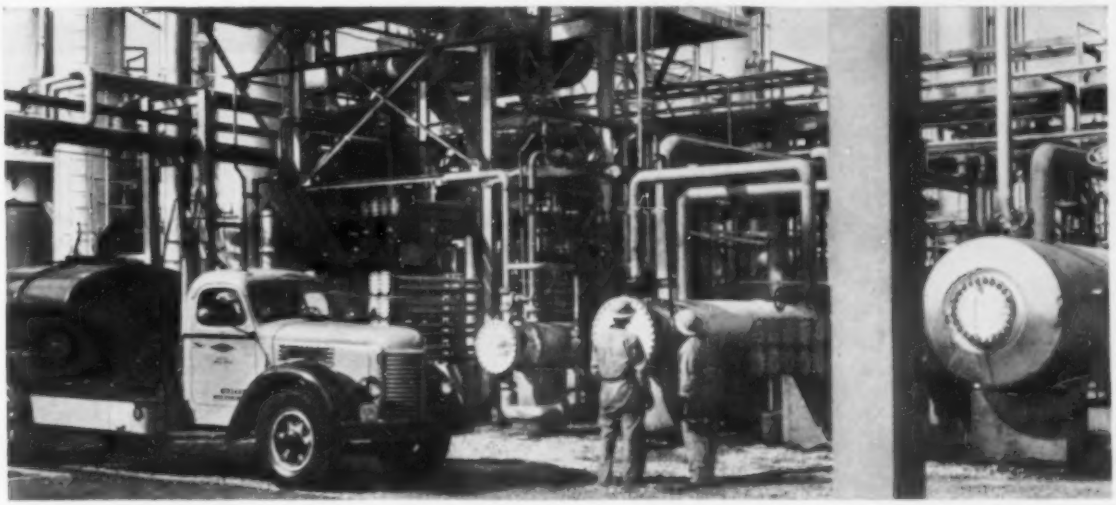
Farbwerke Hoechst, also near Frankfurt, plans to use natural gas from the Darmstadt oilfields to produce methyl chloride, chloroform, carbon tetrachloride, and other solvents.

An interesting sidelight in the reports on the plans of Hoechst is that the firm is studying the possibility of setting up a plant to make ethylene and vanadium-free coke from crude oil, the coke being aimed at aluminum manufacture.

It's all small potatoes yet, however. Output of the petrochemicals will remain small in comparison to volume of chemicals produced on the coal-acetylene basis. This is mainly because coal-chemical production seems to offer almost all the products needed by industry and because coal, of which West Germany still has large reserves will remain a cheap raw material for some time. —W. C. U.

CATALYTIC CRACKER OUTPUT INCREASED 6000 BBLS. PER DAY

Slurry exchangers cleaned chemically by Dowell Service in only 12 hours with profitable results



Through-put on a fluid catalytic cracker in a large refinery was reduced because deposits badly fouled the slurry exchangers. Dowell chemically cleaned the shell side of these exchangers in less than 12 hours. As a result of the cleaning, the operator was able to step up the through-put on the cracking unit from 16,000 to 22,000 barrels per day. This increased efficiency also made it possible to postpone a proposed shut-down for a major overhaul of the unit.

On another catalytic cracker, the increased through-put resulting from Dowell Service had an estimated value of $4,300 per day.

All types of equipment on catalytic crackers have been cleaned effectively by Dowell's chemical methods . . . *without dismantling and with a minimum of downtime.* Dowell furnishes trained personnel and all necessary equipment. Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing. These solvents are designed to remove deposits quickly, efficiently and economically. Often equipment may be cleaned while it is in operation.

Call Dowell for assistance on your maintenance cleaning problems. Experienced Dowell engineers will be glad to talk with you. No obligation, of course.

INFORMATIVE PAMPHLET gives description of how Dowell Service saves time and money in cleaning refinery equipment. Call your local Dowell office or write directly to Tulsa, Dept. A-32.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers · Condensers · Heat Exchangers · Cooling Systems
Pipe Lines · Piping Systems · Gas Washers · Process Towers
Process Equipment · Evaporators · Filter Beds · Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

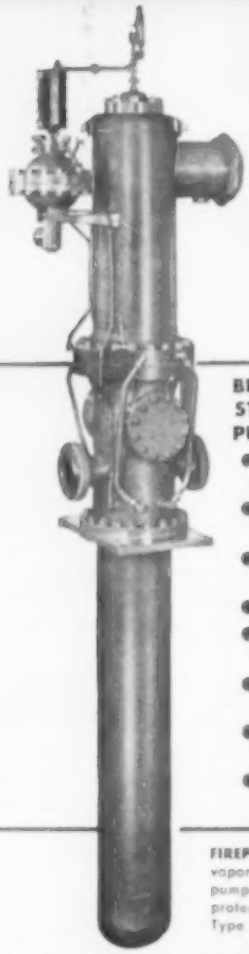
DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

 (To obtain more data on advertised products see page 108)

Bingham STUFFINGBOXLESS PUMPS

HANDLE LIGHT HYDROCARBONS* AT HIGH SUCTION PRESSURES



NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300°).

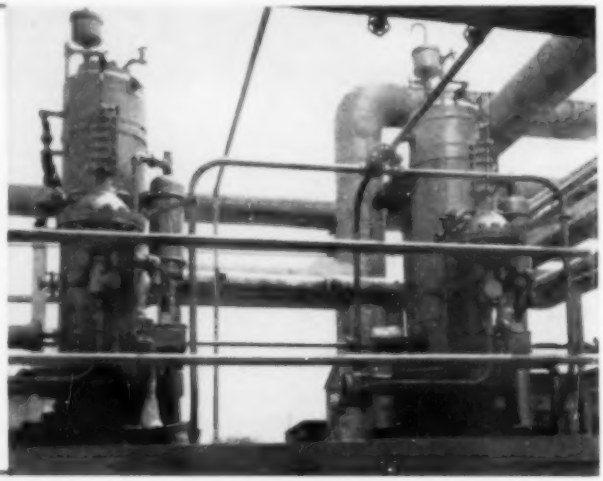
Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F. and higher also can be handled.

Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

*And other volatile liquids.

BINGHAM STUFFINGBOXLESS PUMPS OFFER:

- Lower overall installed cost
- Less operating attendance
- No misalignment of moving parts
- Smooth operation
- No auxiliary lubricating system
- No exposed moving parts
- Positive motor cooling
- All parts are accessible



FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor to atmosphere or leakage from outside into pump is impossible. Not only is plant and personnel protected, but loss of valuable pumpage is prevented. Type KT Multi-Stage Stuffingboxless Pump illustrated.

Battery of Bingham Type KT Stuffingboxless Pumps handling light hydrocarbon at low temperature, under high suction pressure. Tennessee Gas Transmission Co. plant, Gabe, Kentucky.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

SALES AND SERVICE OFFICES

BOSTON, MASS.	PITTSBURGH, PA.
CHICAGO, ILL.	SAN FRANCISCO, CALIF.
DENVER, COLO.	SEATTLE, WASH.
HOUSTON, TEXAS	ST. LOUIS, MO.
KANSAS CITY, MO.	ST. PAUL, MINN.
NEW ORLEANS, LA.	TULSA, OKLA.
NEW YORK CITY, N.Y.	TORONTO, ONT., CAN.
PHILADELPHIA, PA.	VANCOUVER, B.C., CAN.

Letters

The 1955 Forecast

TO THE EDITOR: . . . This is, as always, interesting, and I think quite well done in view of what we can now see. ["What 1955 Will Bring Refiners," by V. B. Guthrie, December, 1954, pp. 1867-71]. However, some years ago I had the pleasure of introducing one of the leading national economists at a National Petroleum Association meeting, and he made a series of predictions which were exceedingly blue, but very believable at that particular moment. Fortunately for the industry, in three or four months conditions had completely reversed, so I generally read predictions with my fingers crossed.

However, this experience with the NPA speaker didn't shake my confidence in him, and I trust that PETROLEUM PROCESSING'S predictions will work out favorably.

W. S. ZEHRUNG

President
The Pennzoil Co.
Oil City, Penna.

• *We trust so too.*

TO THE EDITOR: . . . The only suggestion I have, which you may consider for next year, is that the demand figures may be more clearly understood if they are presented in daily averages rather than total barrels for the year. The industry more or less is attuned to thinking in terms of barrels per day, and I believe the correlation with your capacity figures would be easier for the reader if such figures were used.

N. G. DUMBROS

Manager,
Economics & Statistics Dept.
The Ohio Oil Co.
Findlay, Ohio.

Red Face Department

TO THE EDITOR: . . . I certainly liked the way my article ["How Much Can a Pump Pump?" October, pp. 1576-77] was set up. However, I detected one error in the second example on page 1577. The equation reads;

$$LEH = (P_A - P_V) \pm H_E - H_F$$
$$= (34 - 0.6) - 10 - 2$$
$$= 31.8 \text{ ft.}$$

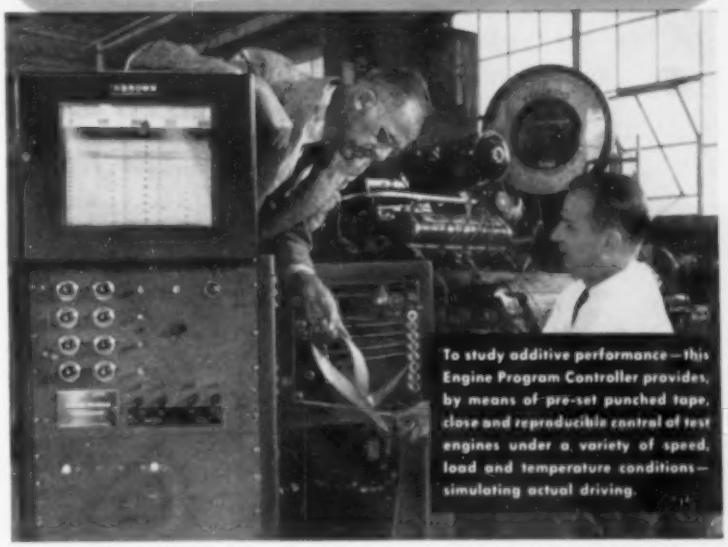
It should have read:

$$LEH = (P_A - P_V) \pm H_E - H_F$$
$$= (33 - 11.2) - 12 - 2$$
$$= 31.8$$

R. A. MILLER

Allis Chalmers Mfg. Co.
Milwaukee, Wisc.

Ask about Oronite's "custom-formulation" of lube oil additives



To study additive performance—this Engine Program Controller provides, by means of pre-set punched tape, close and reproducible control of test engines under a variety of speed, load and temperature conditions—simulating actual driving.

Better oil performance at a competitive treating cost

Oronite specializes in "custom-formulating" additives to your exact needs—meeting your price and performance specifications. Because of Oronite's advanced research, testing and manufacturing facilities, custom-compounding has been accomplished at progressively lower treating costs.

With a years-ahead additive program it is possible that Oronite could provide your finished oil with competitive advantages you need to win and hold a market.

Why not talk it over with an Oronite additive specialist. Contact our office nearest you.

With Oronite Additives you can formulate oils to meet the new A.P.I. Service Classifications and can meet specifications for 2-104-B, MIL-O-2104, Supplement 1 and Series 2 oils.

OTHER ORONITE PRODUCTS
Gas Odorants
Polybutenes
Phenol
Wetting Agents
Fuel Oil Additives

ORONITE CHEMICAL COMPANY
200 Bush Street, San Francisco 20, California
30 Rockefeller Plaza, New York 20, New York
20 North Wacker Drive, Chicago 6, Illinois
714 W. Olympic Blvd., Los Angeles 15, California
Mercantile Securities Building, Dallas 1, Texas

ORONITE CHEMICAL COMPANY

(To obtain more data on advertised products see page 108)

Shaped

...to work under pressure

The shapes shown are Hortonspheroids®—pressure containers for the storage of volatile liquids such as motor gasolines and natural gasolines. No evaporation from volatile liquids can occur as long as the internal pressure does not exceed the pressure relief valve settings.

CB&I builds Hortonspheroids in standard capacities to 120,000 bbls. and in the smaller capacities for pressures to 100 lbs. per sq. in. Please write our nearest office for further information.

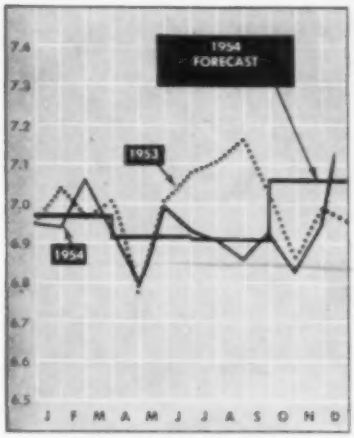
Two 15,000-bbl. Hortonspheroids at the Union Oil Company, Wilmington, California. Both are designed for 15 lbs. per sq. in. working pressure.

CB&I

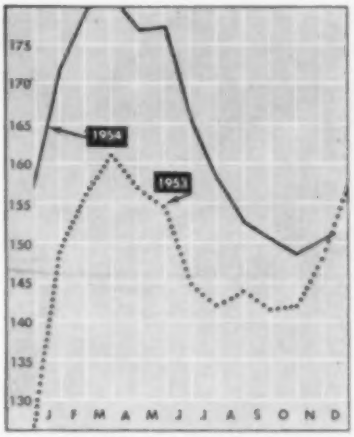
Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa • Washington
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

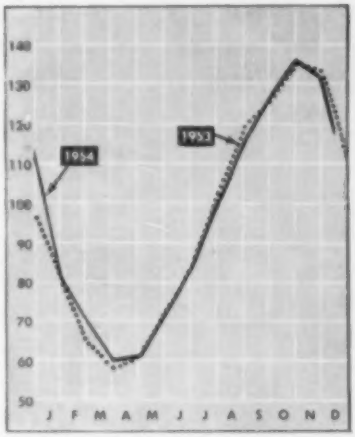
(To obtain more data on advertised products see page 108)



CRUDE RUNS TO STILLS
(Millions of b/d, monthly averages)



PRIMARY GASOLINE STOCKS
(Millions of bbls., end of month)



PRIMARY DISTILLATE STOCKS
(Millions of bbls., end of month)

Sharp Demand Eats Into Refiners' Stocks

OUTLOOK: Crude runs will remain on the new higher level. Stronger gasoline and middle distillate demand than forecast is indicated in early 1955. The unexpected spurt in residual fuel demand will keep refiners in the east scratching for supplies.

The combination of reviving demand for petroleum in general, the resulting firmer markets, and low early winter temperatures, brought larger product shipments by refiners in December than had been forecast, including residual fuels. While refiners stepped up their runs substantially, the large demand for middle distillates necessitated material withdrawals from inventories. The seasonal build-up in gasoline stocks to middle December is much smaller than in 1953.

An indicator of still higher crude runs is the large increase in Texas allowable production for January (257,307 b/d).

Gasoline demand in November was 2.6% larger than in November, 1953, while 10 months shipments were only 1.6% larger. The indicated rate of increase was higher in December. Plant output is largely going to meet current demand and the increase in stocks in November and to Dec. 17 was only around 2,000,000 bbls., while a year ago in the same weeks 10,000,000 bbls. went into refiners' tanks. Inventories Dec. 17 were about the same as in 1953; early this summer they were 20,000,000 bbls. higher.

Shipments of middle distillates (kerosine and distillate fuels) in November were 10% larger than the year before, while for 10 months they were only 1.7% larger. Indicated rate of gain in December is even higher, under the stimulus to heating oil consumption of lower than normal temperatures in the east. In November and to Dec. 17, U. S. middle distillate stocks had been drawn on by 25,200,000 bbls., while a year ago withdrawals were 16,800,000 bbls. Total U. S. stocks Dec. 17 were 150,000,000 bbls., last year on Dec. 19 they were around 155,150,000 bbls.

Unexpected strength in residual fuels is a feature of the present market, the demand coming both from the U. S. and outside countries. The low rate of refinery output and small volume of stocks compared with other products makes this market quickly susceptible to increases in demand.

KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	Dec. 1954*	Nov. 1954	Dec. 1953
CRUDE OIL			
U.S. Production	6.325	6.246	6.240
Imports	.613	.663	.617
U.S. Stocks	265.493	267.641	270.811
Runs to Stills	7.130	6.955	6.947
GASOLINE			
Refinery Output	3.502	3.408	3.453
Refinery Demand	3.424	3.481	3.253
Primary Stocks	151.778	150.441	157.872
MIDDLE DISTILLATES			
Refinery Output	1.967	1.918	1.794
Refinery Demand	3.066	2.135	2.726
Primary Stocks	150.018	168.702	140.425
RESIDUALS			
Refinery Output	1.114	1.115	1.247
Imports	.511	.391	.490
Total Supply	1.625	1.506	1.734
Refinery Demand	1.777	1.558	1.809
Primary Stocks	52.265	54.851	49.370

* Through Dec. 17, except Crude Stocks, which are B. of M. data one day later.

PRODUCT AND CRUDE PRICES

Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$/bbl., principal fields
Source—Platt's Oilgram Price Service

	Dec. 1954*	Nov. 1954	Dec. 1953
Gasoline	11.26	11.24	12.18
Distillates	9.00	8.90	8.96
Kerosine	10.53	10.42	10.29
Residuals	4.03	4.06	4.21
Above 4 Products	8.71	8.70	9.21
Lube Oils	16.46	16.34	17.53
Crude	2.81	2.81	2.83

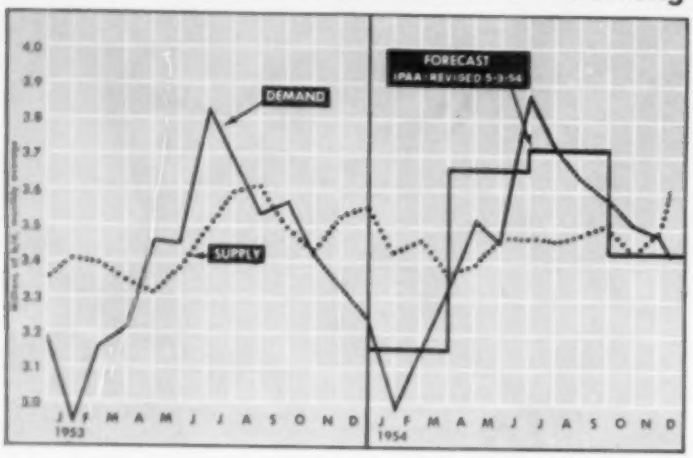
REFINERY YIELDS

% on Crude Runs to Stills	Dec. 1954*	Nov. 1954	Dec. 1953
Gasoline	44.3	43.8	44.8
Kerosine	5.2	5.0	5.2
Distillates	22.4	22.5	20.5
Residuals	15.6	16.0	17.8

* Through Dec. 17.

SOURCE OF DATA (except prices): Oct., Nov. and Dec., API weekly reports; earlier months, Bureau of Mines

Gasoline Demand Holds Strong in December

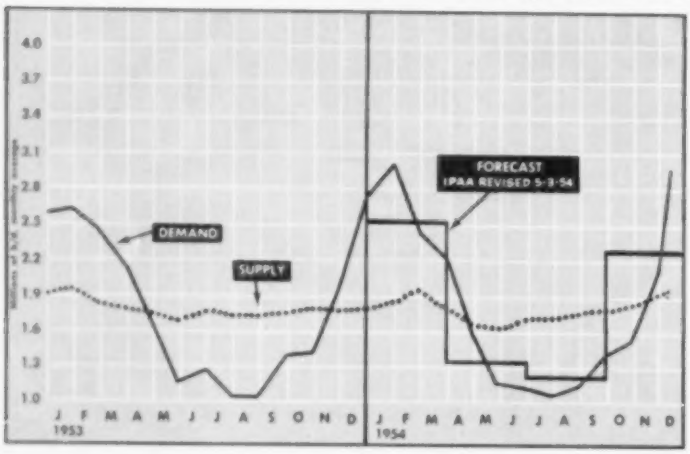


MOTOR FUEL

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Dec. '54*	3.162	.450	3.612
Dec. '53	3.135	.417	3.552
Change	+.027	+.033	+.060
% Change	+0.9	+7.9	+1.7
DEMAND (including Exports) (Millions of b/d)			
Dec. '54*			3.424
Dec. '53			3.253
Change			+.171
% Change			+5.3
TOTAL SUPPLY (Millions of bbls.)			
11 Mos. '54	1,014.694	141.335	1,156.029
11 Mos. '53	1,025.489	131.316	1,156.805
Change	−10.795	+10.019	−.776
% Change	−1.1	+7.6	—
TOTAL DEMAND (Millions of bbls.)			
11 Mos. '54			1,166.825
11 Mos. '53			1,143.410
Change			+23,415
% Change			+2.0

* Through Dec. 17 only; may not be indicative of the trend for the entire month.

Current Distillate Shipments Well Over 1953

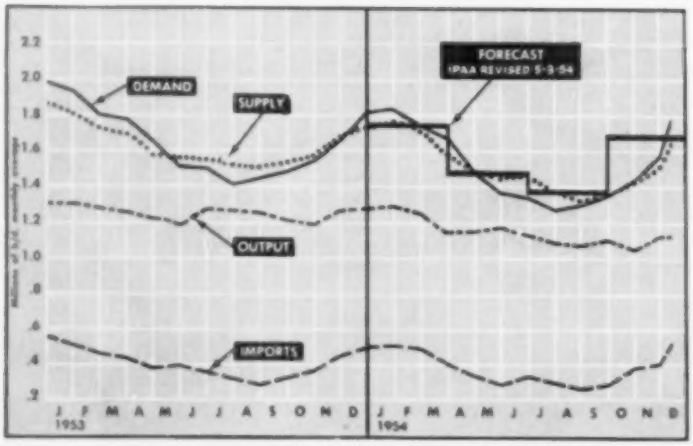


MIDDLE DISTILLATES

	Kerosine	Dist. Fuels	Total
PRODUCTION (Millions of b/d)			
Dec. '54*	.369	1.598	1.967
Dec. '53	.362	1.432	1.794
Change	+.007	+.166	+.173
% Change	+1.9	+11.6	+9.6
DEMAND (including Exports) (Millions of b/d)			
Dec. '54*	.596	2.470	3.066
Dec. '53	.587	2.139	2.726
Change	+.009	+.331	+.340
% Change	+1.5	+15.5	+12.5
TOTAL PRODUCTION (Millions of bbls.)			
11 Mos. '54	110.416	488.188	598.604
11 Mos. '53	111.970	483.716	595.686
Change	−1.554	+4.472	+2.918
% Change	−1.4	+0.9	+0.5
TOTAL DEMAND (Millions of bbls.)			
11 Mos. '54	104.579	471.353	575.932
11 Mos. '53	103.532	455.074	558.606
Change	+1.047	+16.279	+17.326
% Change	+1.0	+3.6	+3.1

* Through Dec. 17 only; may not be indicative of the trend for the entire month.

Upturn in Demand Extends to Residual Fuels



RESIDUAL FUELS

	Refinery Output	Imports	Total
SUPPLY (Millions of b/d)			
Dec. '54*	1.114	.511	1.625
Dec. '53	1.247	.487	1.734
Change	−.133	+.024	−.109
% Change	−10.6	+5.0	−6.3
DEMAND (including Exports) (Millions of b/d)			
Dec. '54*			1.777
Dec. '53			1.809
Change			−.032
% Change			−1.8
TOTAL PRODUCTION (Millions of bbls.)			
11 Mos. '54	379.156	115.427	494.583
11 Mos. '53	411.327	121.115	532.442
Change	−32.171	−5.688	−37.859
% Change	−7.8	−4.7	−7.1
TOTAL DEMAND (Millions of bbls.)			
11 Mos. '54			494.282
11 Mos. '53			535.067
Change			−40.785
% Change			−7.6

* Through Dec. 17 only; may not be indicative of the trend for the entire month.

SOURCE OF DATA: Oct., Nov. and Dec., API weekly reports, earlier months, Bureau of Mines

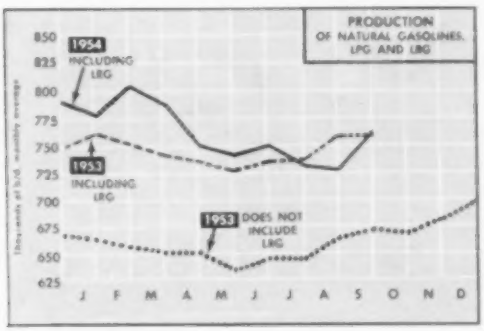
RUNS TO STILLS and DISTRIBUTION OF PRIMARY STOCKS BY U.S. REFINERY DISTRICTS

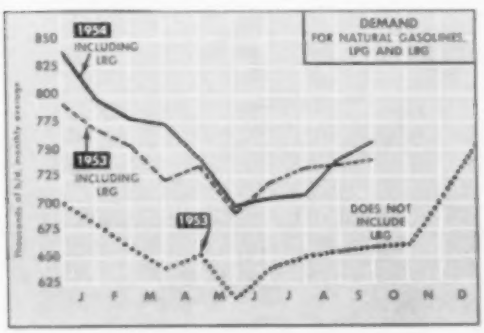
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Dec. 10 1954	Dec. 11 1953	Change	% Change	GASOLINE STOCKS (Millions of bbls., on date shown) Dec. 10 1954	Dec. 11 1953	Change	% Change	RESIDUAL STOCKS (Millions of bbls., on date shown) Dec. 10 1954	Dec. 11 1953	Change	% Change
East Coast	1.040	.976	+ .064	+ 6.6	32.951	33.288	— .337	— 1.0	8.959	11.642	—2.683	—23.0
Gulf Coast	2.402	2.283	+ .119	+ 5.2	32.817	30.374	+2.443	+ 8.0	6.144	8.375	—2.231	—26.6
Total Coastal	3.442	3.259	+ .183	+ 5.6	65.768	63.662	+2.106	+ 3.3	15.103	20.017	—4.914	—24.5
Appalachian	.170	.187	— .017	— 9.1	6.840	6.167	+ .673	+10.9	.822	1.059	— .237	—22.4
Ind.-Ill.-Ky.	1.288	1.298	— .010	— 0.8	31.314	30.293	+1.021	+ 3.4	3.851	4.657	— .806	—17.3
Okla.-Kans.-Mo.	.637	.585	+ .052	+ 8.9	13.564	15.925	—2.361	—14.8	1.380	1.290	+ .090	+ 7.0
Other Inland	.572	.568	+ .004	+ 0.7	15.066	14.504	+ .562	+ 3.9	2.303	2.504	— .201	— 8.0
Total Inland	2.667	2.638	+ .029	+ 1.1	66.784	66.889	— .105	— 0.2	8.356	9.510	—1.154	—12.1
Total East of Calif.	6.109	5.897	+ .212	+ 3.6	132.552	130.551	+2.001	+ 1.5	23.459	29.527	—6.068	—20.6
California	.996	1.018	— .022	— 2.2	18.101	19.843	—1.742	— 8.8	29.344	20.928	+8.416	+40.2
Total U.S.	7.105	6.915	+ .190	+ 2.7	150.653	150.394	+ .259	+ 0.2	52.803	50.455	+2.348	+ 4.7

District	DISTILLATE STOCKS (Millions of bbls., on date shown) Dec. 10 1954	Dec. 11 1953	Change	% Change	KEROSINE STOCKS (Millions of bbls., on date shown) Dec. 10 1954	Dec. 11 1953	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbls., on date shown) Dec. 10 1954	Dec. 11 1953	Change	% Change
East Coast	45.483	47.913	—2.430	— 5.1	12.877	14.665	—1.788	—12.2	58.360	62.578	—4.218	— 6.7
Gulf Coast	20.558	21.677	—1.119	— 5.2	7.621	5.528	+2.093	+37.9	28.179	27.205	+ .974	+ 3.6
Total Coastal	66.041	69.590	—3.549	— 5.1	20.498	20.193	+ .305	+ 1.5	86.539	89.783	—3.244	— 3.6
Appalachian	3.199	2.254	+ .945	+41.9	1.110	1.235	— .125	—10.1	4.309	3.489	+ .820	+23.5
Ind.-Ill.-Ky.	23.148	22.984	+ .164	+ 0.7	8.656	8.596	+ .060	+ 0.7	31.804	31.580	+ .224	+ 0.7
Okla.-Kans.-Mo.	12.509	11.957	+ .552	+ 4.6	2.261	1.703	+ .558	+32.8	14.770	13.660	+1.110	+ 8.1
Other Inland	6.311	6.020	+ .291	+ 4.8	1.278	1.253	+ .025	+ 2.0	7.589	7.273	+ .316	+ 4.3
Total Inland	45.167	43.215	+1.952	+ 4.5	13.305	12.787	+ .518	+ 4.1	58.472	56.002	+2.470	+ 4.4
Total East of Calif.	111.208	112.805	—1.597	— 1.4	33.803	32.980	+ .823	+ 2.5	145.011	145.785	— .774	— 0.5
California	12.859	13.647	— .788	— 5.8	.407	.383	+ .024	+ 6.3	13.266	14.030	— .764	— 5.4
Total U.S.	124.067	126.452	—2.385	— 2.0	34.210	33.363	+ .847	+ 2.5	158.277	159.815	—1.578	— 1.0

Natural Gas and Refinery Gas Liquids





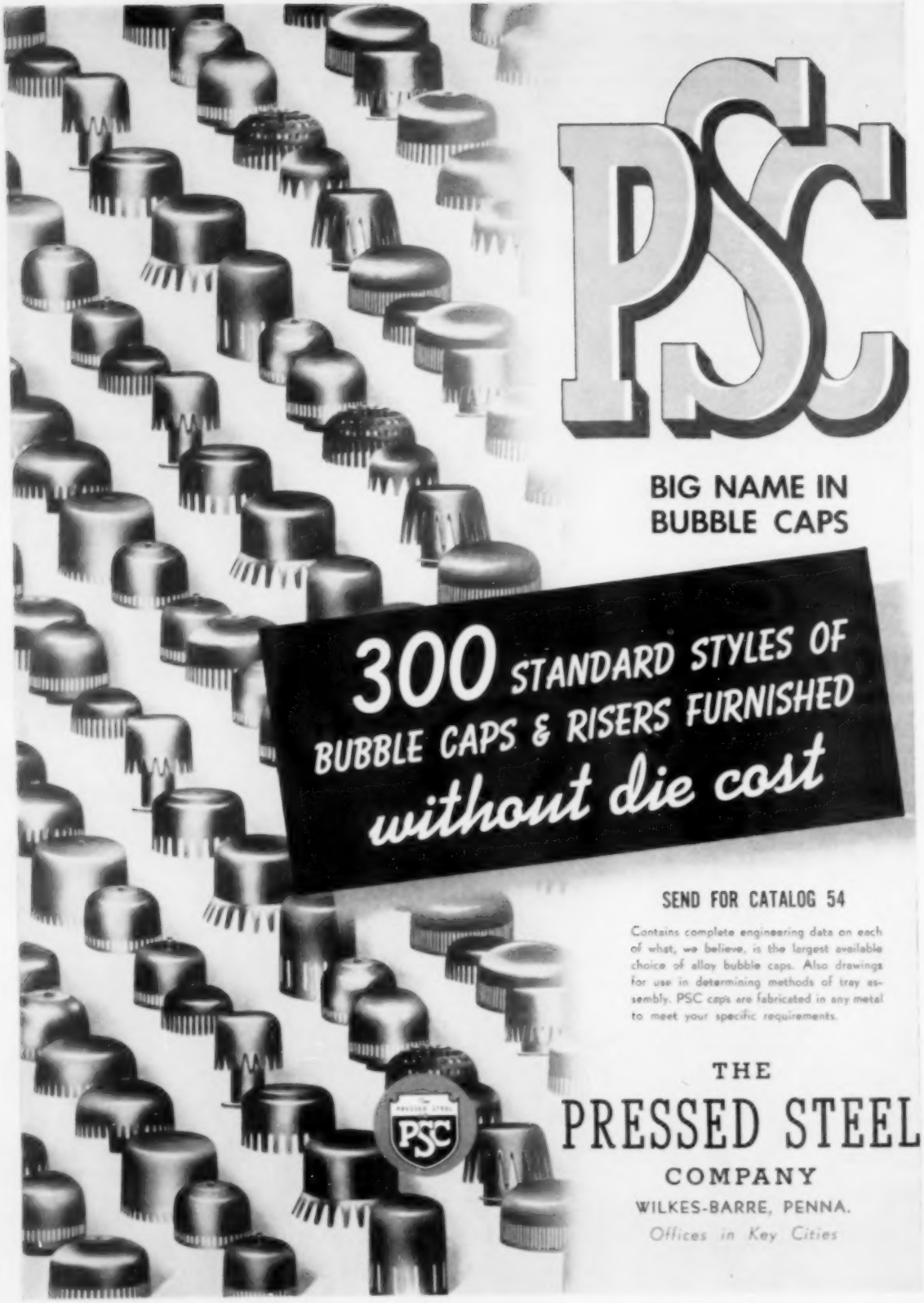
SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	Sept. 1954	Aug. 1954	Sept. 1953
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	315	289	312
Natural Gasoline and Isopentane	273	272	270
Condensate	25	25	25
Finished Gasoline, Naphtha and Other	63	56	67
Total Natural Gasoline and Cycling Plant Production	676	642	674
Liquefied Refinery Gases	89	88	87
Total Marketable Gas Liquids	765	730	761
Lease Condensate	93	94	89
Total Natural Gas Liquids	858	824	850
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	400	363	380
Natural Gasoline, Isopentane and Other	355	376	357
Total Current Demand	755	739	737

CUMULATIVE PRODUCTION (1000 bbls.)	Sept. 1954	Sept. 1953
LPG and LRG	111,784	107,986
Natural Gasoline, Isopentane and Other	95,941	95,941
Total Marketable Gas Liquids	207,725	203,927
CUMULATIVE DEMAND (1000 bbls.)		
LPG and LRG	106,544	103,940
Natural Gasoline, Isopentane and Other	96,079	95,900
Total Cumulative Demand	202,623	199,840

STOCKS (1000 bbls., end of Month)	Sept. 1954	Aug. 1954	Sept. 1953
LPG and LRG	9,716	9,581	5,080
Natural Gasoline, Isopentane and Other	4,751	4,572	5,369
Total Stocks	14,467	14,153	10,449


PSC
BIG NAME IN
BUBBLE CAPS
300 STANDARD STYLES OF
BUBBLE CAPS & RISERS FURNISHED
without die cost
SEND FOR CATALOG 54
Contains complete engineering data on each of what, we believe, is the largest available choice of alloy bubble caps. Also drawings for use in determining methods of tray assembly. PSC caps are fabricated in any metal to meet your specific requirements.
THE
PRESSED STEEL
COMPANY
WILKES-BARRE, PENNA.
Offices in Key Cities

Here's The New Liquid Level Control Pilot Everybody's Talking About!

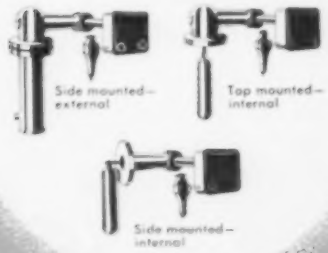
It's The New BS&B CLIMAX Type 1450!

After more than two years of development and thorough field testing under all conditions, the new BS&B CLIMAX Type 1450 Liquid Level Control Pilot is now available, and is already the most talked about instrument of its kind in the industry today!

Type 1450 is the *only* liquid level controller on the market which is so versatile that it can be used for liquid level transmission service, proportional throttling service *and* for "on-off" snap action! This makes it easy for you to transfer it quickly from one service to another, as your needs may require.

You will be surprised and pleased with its performance and simplicity. Call or write your BS&B Representative. He will be glad to give you the complete story on this all-new liquid level control pilot.

Type 1450 Mounts To Torsion Tube Controller In 3 Ways:



CONSTRUCTION FEATURES

- √ Weatherproof Case Of Die Cast Aluminum Designed For Universal Mounting.
- √ Compact Size — 8" x 8" x 4".
- √ Two-Way Door Opens From Either Left Or Right, As Convenient.
- √ Straight Line Piping.
- √ Push Button Feed Orifice Cleaner.
- √ Pilot Action Reversible By Moving A Single Link, Without Tools.
- √ Snap Action Or Proportional Band Settings Can Be Made Without Tools.
- √ No Loose Linkages, Resulting In Easier Adjustment And Greater Sensitivity.
- √ Easy Parts Replacement Or Assembly.

OPERATIONAL FEATURES

Straight Line Proportional Action!

- √ Factory Calibration Of Proportional Bellows, Feed Orifice Nozzle and Proportional Snap Action Band Scale.
- √ Spring Loaded Bellows With Built-In Overtravel Protection.
- √ Flow Tested Feed Orifice Nozzle With Graduated Micrometer Set Point Adjustment.
- √ Reflects Changes In Liquid Level, Changes In Gravity.
- √ Can Be Used For Liquid Level Transmission Service, Proportional Throttling Service Or "On-Off" Snap Action.

Improved Sensitivity and Faster Controller Response Through The Power Relay Mechanism

- √ Double Diaphragm, Pressure Balanced.
- √ Molded Diaphragms.
- √ High Capacity Pilot Valve.
- √ Intermittent Bleed.

For Better Process Controls . . . Always Specify BS&B Climax!

BLACK, SIVALLS & BRYSON, INC.
Climax Controls Division, Dept. 4-D1
7500 East 12th Street • Kansas City 26, Missouri

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY

MORE POWER TO TRINIDAD.

(CANADA)

. . and to Trinidad's customers with

Platforming

something to be pleased about

HERE'S ANOTHER EXAMPLE of the remarkable results now being obtained with the UOP Platforming process. It is also an example of progressive thinking . . . and progressive acting . . . on the part of Trinidad Leaseholds (Canada) Limited.

By installing this UOP Platformer, Trinidad has greatly improved its position as a producer of high quality motor fuels. Former refining methods required the use of almost the maximum amount of tetraethyl lead in order to meet octane requirements of Trinidad's marketing area. With the Platformer, Canadian crudes are being processed . . . the octane numbers have been substantially raised . . . and a sharp reduction in the amount of tetraethyl lead used has been accomplished.

The finished product . . . well above average octane for the southern Ontario marketing area . . . enables Trinidad to supply its 500 retail outlets with an exceptionally high quality motor fuel on a more profitable basis than was possible before.

Trinidad's Platformer has a design capacity of 1,500 B/SD. However, provision has been made to raise the capacity to 2,300 B/SD in line with a planned modernization program which will result in Trinidad doubling the daily throughput of its refinery.

Platforming . . . the catalytic reforming process which pioneered the use of platinum catalyst . . . offers many important advantages. Why not talk over with us the application of Platforming to your operation?

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U. S. A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service
Protects Your Investment

Gilbarco

West Springfield, Mass.
Toronto, Canada

Gilbert & Barker Mfg. Co.
West Springfield, Mass.

Gentlemen:

Please send me brochure on the Gilbarco Electronic Tank Gauge.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

NOW YOU CAN MAINTAIN 100% GREATER ACCURACY

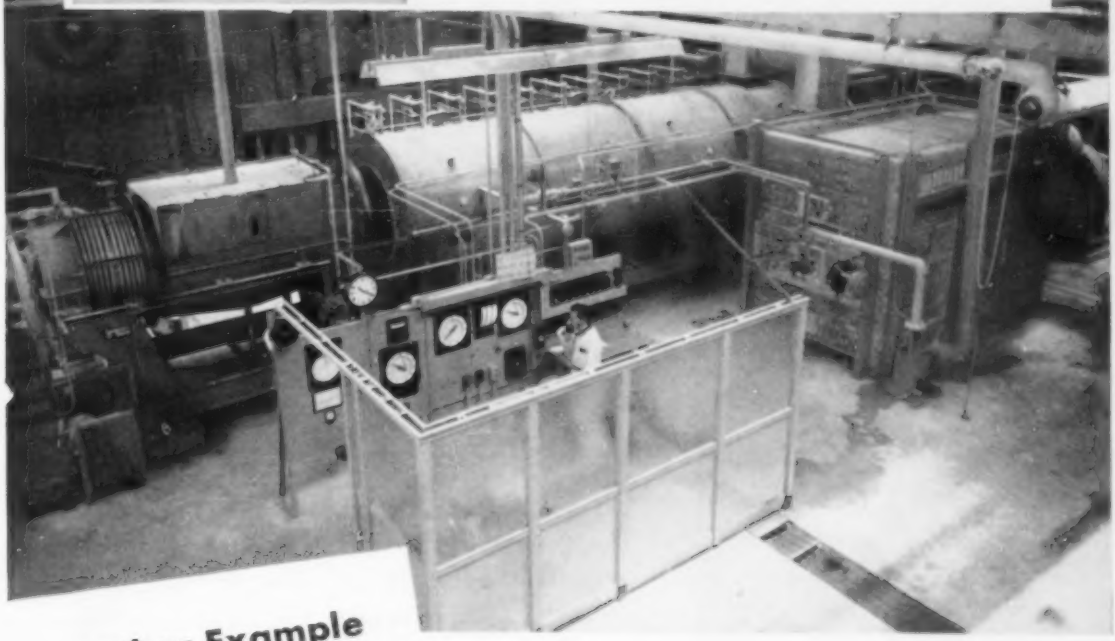
This coupon will bring you full information on a revolutionary

NEW ELECTRONIC TANK GAUGE

The new Gilbarco Electronic Tank Gauge, the result of years of laboratory research and field testing, actually *measures electronically*. No adjustments needed for varying specific gravities or viscosities. Can be installed *without* taking tank out of service. Liquid is measured with a degree of accuracy never before approached by any other method of gauging. And equally accurate readings can be made at remote points. Get full information on this revolutionary new gauge *today*.

Nalform

FLUID HYDROFORMING CATALYST PRODUCTION CAPACITY . . .



another Example of Service to further Petroleum Industry Progress

● Fluid hydroforming to upgrade petroleum products is one of the typically rapid advances in the Petroleum Industry that the Nalco Catalyst Division is proud to have had a part in making possible.

Standard Oil Development Company and Nalco Catalyst Division worked together in developing Nalform Hydroforming Catalyst. In a surprisingly short time, Nalform was being produced in commercial quantities.

Nalform and Nalcat Catalysts are good examples of the abilities and facilities of Nalco Catalyst Division to produce and provide service to match petroleum industry progress.

Nalcat® Nalform

Production and Service to Match Petroleum Industry Progress

CATALYST DIVISION — NATIONAL ALUMINATE CORPORATION
4003 West 71st Street • Chicago 29, Illinois

Better Check

ORBIT can prevent losses

There was a time when Orbit Forged Steel ASA Class valves were used chiefly in the tough services by plant men — now they are being widely used throughout hydrocarbon plants because they have proven to be the most economical valve to operate over the long run. You can depend upon Orbit Valves for a positive shut-off and a very low maintenance cost.

Engineering and construction companies who design and build plants have often in the past been required to figure dual valving for some installations. This is no longer necessary when Orbit Valves are specified. Take the matter of Orbit ASA Class Valves up with the engineering company figuring with you on a new plant or an expansion job. They know about Orbit Valves, too.

Orbit Forged Steel ASA Class Valves are offered in sizes beginning with 1″ through 6″, A.S.A. Class, 150 pound to 2500 pound Series. Maximum rated working temperature 250° Fahrenheit.

BRANCHES

HOUSTON, TEXAS
407 Velasco
(Serving the Gulf Coast)

ODESSA, TEXAS
402 West County Road
(Serving West Texas)

CASPER, WYOMING
247 West First Street
(Serving the Rocky Mountain States and Canada)

There Is ONLY ONE ORBIT VALVE

ORBIT VALVES ®

ORBIT VALVE COMPANY

P. O. BOX 699 TULSA, OKLAHOMA

does *Your*

Motor Fuel's Mileage

Fluctuate with the Temperature?

then

"RETAINED VOLATILITY"

is the answer!

Blending with Warren NATURAL GASOLINE will give it the RETAINED VOLATILITY so necessary for superior performance after it reaches the fuel tanks of your customers . . . under all temperature variations.

Warren's production, transportation and storage facilities are your assurance of the quality and quantity of NATURAL GASOLINE you need . . . when and where you want it.

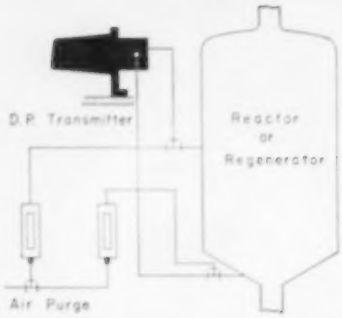
WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.

CATALYST LEVEL

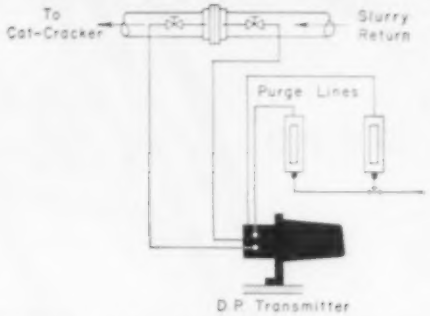


Problem: Sensitive Level Measurement of fluid catalyst in Reactor or Regenerator requiring a range of approximately 600 inches of water, and with a unit having parts common to other process measuring elements.

Solution: Use of a 333RD force-balance differential pressure transmitter with an available range adjustment of 80 to 800 inches of water.

Result: Accurate, Sensitive and Dependable level measurement with complete interchangeability of pneumatic transmitter parts.

AUTOMATIC PURGING OF SUSPENDED SOLIDS

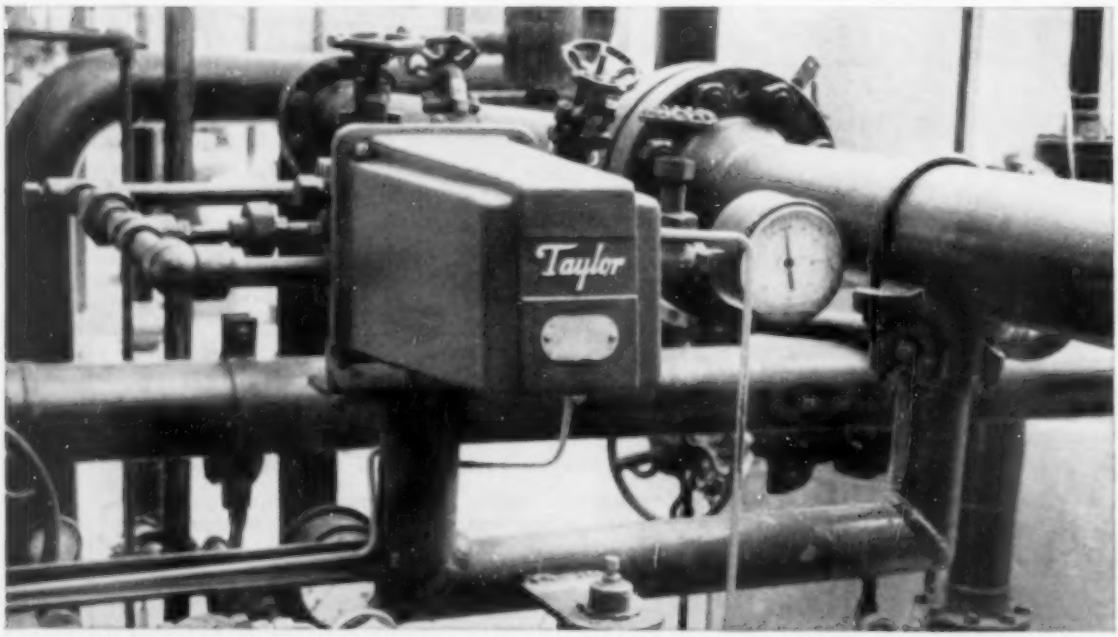


Problem: To obtain uninterrupted flow measurement and control in slurry lines where catalyst solids in suspension can settle out, plugging lead lines and meter, and causing measurement errors.

Solution: Dual body taps provide for purge connections which keep 333RD body, as well as lead lines, completely flushed.

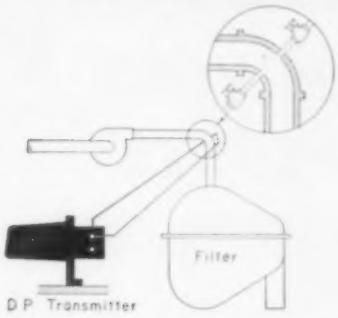
Result: Consistent, dependable high measurement accuracy. Flushing of transmitter body as well as lead lines cuts maintenance to a minimum, especially after shutdown.

A SIMPLE ANSWER TO



One of the TRANSAIRE *Flow Transmitters on a reforming unit at Shell Oil Company's Wood River, Illinois, refinery.*

SHORT RUNS—REVERSE FLOW—VARYING VISCOSITY

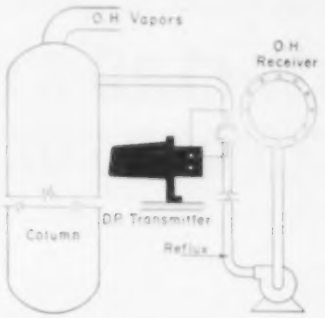


Problem: Dependable flow measurement installation where piping runs are too short for accurate orifice plate installation, the flow is reversed and/or flowing liquid has a varying viscosity.

Solution: The use of the 333RD Transmitter with Elbow Taps as primary elements. Since there is a tendency toward cavitation at the inside tap, the low volumetric displacement of the 333RD makes this type of installation practical.

Result: Accurate measurement and control under any one or more of these three difficult conditions.

WHEREVER A GOOD "WORK HORSE" IS REQUIRED



Problem: To improve flexibility, as well as reduce installation and maintenance costs of conventional flow instruments.

Solution: Standardizing on the 333RD Transmitter. 10-to-1 quick and easy range change; minimum volumetric displacement; may be installed for continuous draining and venting; light weight.

Result: Reduced maintenance cost due to time saved installing, changing of range, and eliminating periodic draining or venting.

DIFFICULT PROBLEMS!

The Taylor TRANSAIRE® Differential Pressure Transmitter (333RD) combines rugged simplicity with remarkable adaptability!

THREE of the applications illustrated above present difficult flow and level measurement problems: the fourth is an every-day installation. In each case the 333RD Transmitter handles the job accurately, dependably and economically.

This very versatile instrument is inexpensive and easy to install, and to maintain; changes in product or seasonal demand cause no problems, due to quick, simple range-change features; it follows flow changes quickly because of low volumetric displacement—has no seal pots.

Some of the features that make it so popular for refinery applications, are:

1. Good overrange protection, due to precisely designed and manufactured back-up plates and use of strong, flexible Teflon-coated glass fabric diaphragm.

2. Negligible temperature effect resulting from proven design principles and use of low-spring-rate materials.

3. Ease of range suppression by means of an easily accessible, easily adjustable spring.

If you need dependably accurate measurement of flow, liquid level or specific gravity, it will pay you to look into the 333RD. Call your Taylor Field Engineer, or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

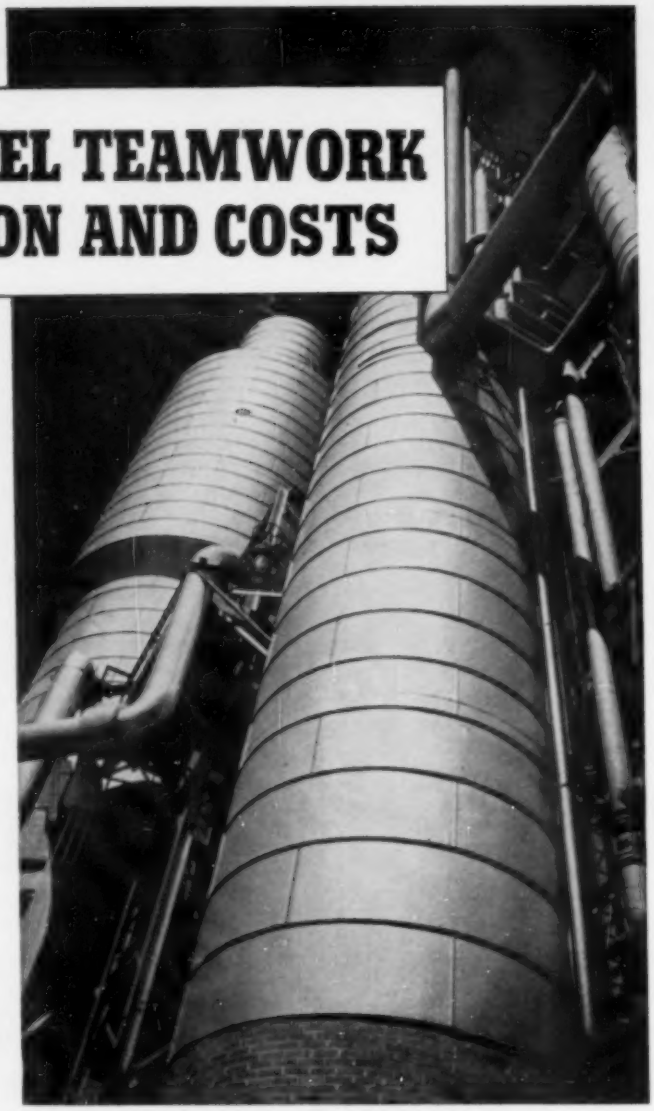
 (To obtain more data on advertised products see page 108)

HOW CLAD STEEL TEAMWORK CUTS CORROSION AND COSTS

Selecting material for this two-stage refinery unit was a double-tough problem. The upper section of the atmospheric tower had to withstand the corrosive action of condensing mineral acids and organic chlorides . . . the lower part had to handle corrosive asphalt crude containing up to 2.50% sulphur concentrations. The vacuum still had to process a lube cut at 750°F. The equipment builder solved the corrosion problem *economically* by teaming up two clad steels: Monel-clad for the upper part and stainless-clad for the lower part of the atmospheric tower, and stainless-clad throughout the vacuum still.

With economical clad steel—a layer of solid high alloy permanently bonded over its entire surface to a low-cost carbon-steel backing plate—there is no possibility of seepage or crevice corrosion . . . no costly maintenance or downtime . . . no equipment failure. In addition, clad steels assure resistance to thermal shock, flexible efficient operation, low first cost and easy economical field erection.

Equipment values like these also result from another kind of teamwork. Sound engineering and modern fabricating techniques can take advantage of the versatility of clad steels. You will find that it pays to consult your fabricators *early* in your planning for tanks and pressure vessels. They can work with your engineers and consultants, translate ideas into the specialized equipment you require.



Two clad steels combine specialized talents to lick corrosion in this 20,000-barrel-per-day refinery unit

Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. The story can suggest new ideas to everyone concerned with production efficiency. Or contact Manager, Marketing Service, Lukens Steel Company, 752 Lukens Building, Coatesville, Pennsylvania.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE

they never get tired!
* YARWAY Single-end Welding-type Gun-Pakt Joint for 150 lbs. pressure.
* Some of the 189 YARWAY Gun-Pakt expansion joints installed at large oil refinery in Texas.

No fatigue with 189 YARWAY GUN-PAKT EXPANSION JOINTS at this large Texas refinery

THEY just work and work for years and never get tired. Yarway Gun-Pakt slip-type joints simply will not fail through fatigue. They will operate smoothly, as frequently as required, over long, full traverse up to 12" single type or 24" double type or short, partial traverse, day in and day out—with never any danger of metal fatigue or failure.

This is just one of the many big advantages found in Yarway Gun-Pakt expansion joints. Other outstanding Gun-Pakt features are:

1. Can be serviced under *full* steam pressure day and night, thus avoiding costly and inconvenient shutdowns.
2. Fixed Gun-Pakt gland serves as "built in" external guide and permits less costly and rigid pipe guidance than required by many other types of joints.
3. Lower pressure load on end anchors because excessive strains are eliminated.

Used for many years with success in well-known refineries, industrial plants, utilities and institutions. When replacing present joints or planning new steam lines, it will pay you to look into the advantages of the Yarway Gun-Pakt expansion joint. Write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
153 Mermaid Avenue, Phila. 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

gun-pakt expansion joints

"THE BRAND OF PROGRESS"

By Heat Exchanger Specialists

▲ SYNOPSIS OF AD #7: Tube Sheet drilling procedures at Western Supply Company assure the highest possible accuracy in readying the tube holes for the operation described below. The infinitesimal drilling tolerances allowed by the Standards of the Tubular Exchanger Manufacturers Association (TEMA) are closely observed. Each hole is fixed with a dead center, individually drilled, then reamed to exact specification. All tube holes drilled at Western are serrated to further avoid any possibility of leaks in the finished tube-to-tube sheet joint.

eighth in a new series of advertisements

WESTERN Gives Vapor/Fluid-Tight Tube to Tube-Sheets Joints With This Fool-Proof Tube Expanding Procedure.

A ticklish job in the construction of any heat exchanger is the expansion of the tube within the tube-sheet to form a vapor and fluid-tight metal to metal joint. The tube is expanded against the tube-hole wall by mechanical pressure. This pressure must be enough to carry the metal just past its elastic limit, establishing a permanent "set" between the tube and the tube sheet. If the metal is overworked, the tube will show evidence of longitudinal expansion indicating an over-thinning of the tube wall, possibly a distortion of the tube sheet, and an unsafe joint.

It is obvious therefore that in order to work thousands of tube to tube-hole fittings the heat exchanger manufacturer must eliminate the "human element" in tube expanding.

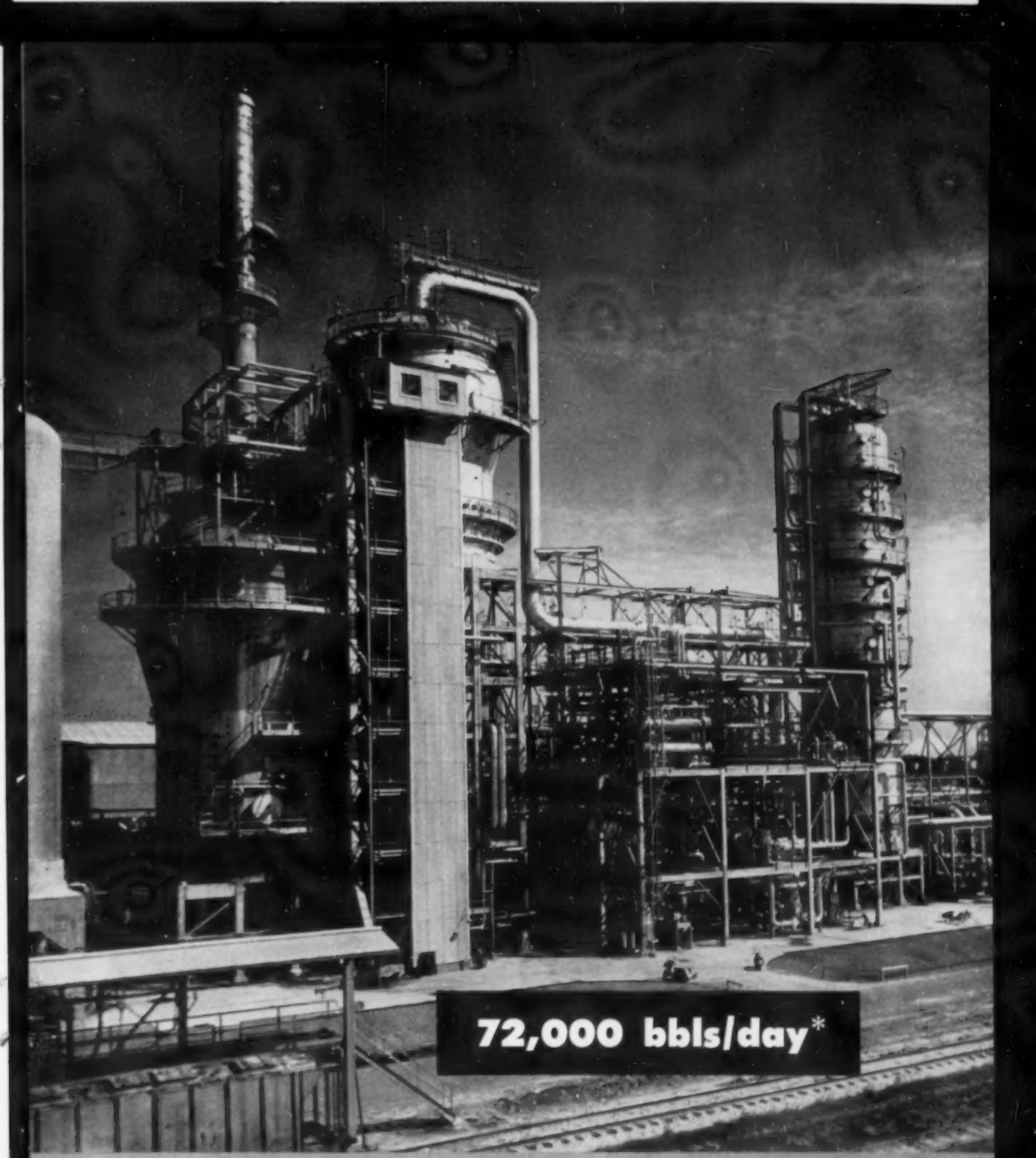
Western solves this problem by 100% application of Controlled Torque Tube Rolling. In this procedure, exact measurements are taken of the I.D. of the tube, the O.D. of the tube, and the I.D. of the tube hole. These measurements are taken to calculate the desired amount of tube wall reduction.

From tables previously established by Western, the electronically controlled tube expander can be set. This setting controls the power or torque used to drive the expander which determines the amount of expansion given to the tube. In this manner it is impossible to overwork the tube. The operator cannot continue to expand the tube without changing the original settings on his dial.

Positive and uniform tube to tube-sheet joints . . . one more reason why you get better performance with WESTERN HEAT EXCHANGERS.

WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY CO.
P. O. BOX 1888 • TULSA, OKLAHOMA

(To obtain more data on advertised products see page 108)



Now "on stream",—this new Fluid Catalytic Cracking Unit at the Norco, Louisiana refinery of the Shell Oil Company. This unit will process 72,000 barrels per day, including recycle*. Mechanical design, engineering and construction by —

FW

FOSTER WHEELER

165 BROADWAY, NEW YORK 6, NEW YORK

How A. O. Smith
Texas polymerization
REACTORS, HEAT
METALLURGICAL
VESSELS

THIS installation shows that A. O. Smith service extends far beyond the usual supplying of vessels and exchangers to order. Here, our metallurgical research served to prescribe the chemical specifications used by the customer to improve the corrosion-resistance of specific reactor linings.

A. O. Smith supplied special pressure vessels, as well as five different kinds of heat exchangers for the phosphoric acid polymerization unit.

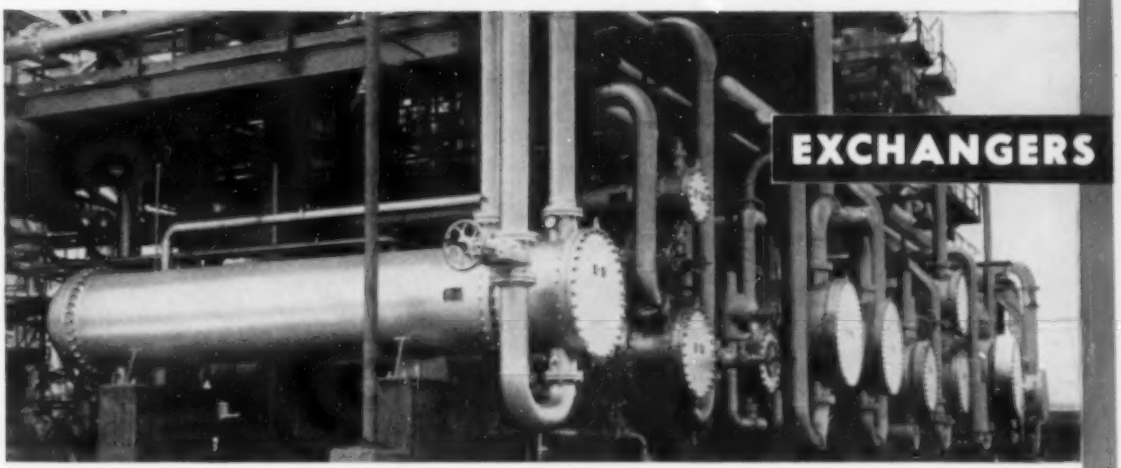
This typical example shows why the petroleum, petro-chemical and chemical industries bring their pressure vessel and heat exchanger problems to A. O. Smith.

Investigate A. O. Smith's performance in terms of your own processing needs. Write our nearest office. We'll be glad to give you detailed information about A. O. Smith pressure vessels and heat exchangers, engineering and research.

(To obtain more data on advertised products see page 108)

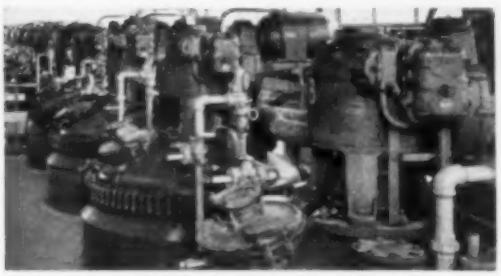
serves refineries

unit uses EXCHANGERS AND RESEARCH



Three A. O. Smith reactors with type 316 ELC lining are the heart of the unit. Designed for operating pressures of 640 psi, the vessels have 102-in. ID . . . are 58 ft. long with 2¾ in. wall thickness.

The unit has 21 A. O. Smith heat exchangers. These include reboilers, condensers, coolers, heaters and exchangers, ranging in diameter from 15 to 51 in. We make all types of heat exchangers required by a petroleum refinery.



Broader service through Glascote — For more than 20 years, our subsidiary, Glascote Products, Inc., Cleveland, has been serving the process industries. Glascote can supply you with corrosion-resistant laboratory and pilot plant reactors . . . single-shell or jacketed storage tanks . . . double-jacketed condensers . . . columns.

Through research . . . a better way

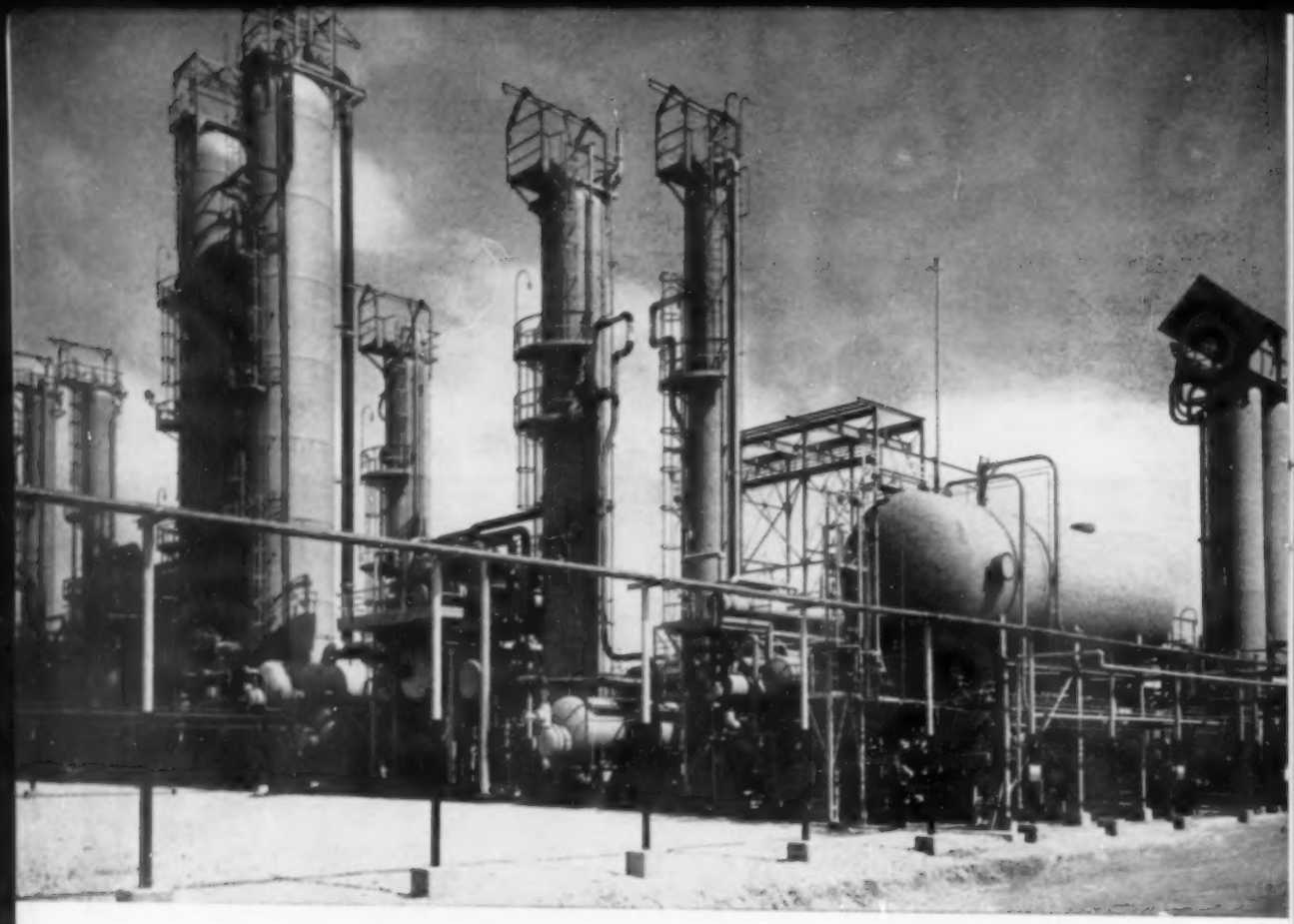
A.O.Smith

CORPORATION

MILWAUKEE • HOUSTON • LOS ANGELES

Glascote Products, Inc., Cleveland, Ohio

International Division: Milwaukee 1



THE REFINERY THAT WAS BOUGHT "SIGHT UNSEEN"

THE owners bought this plant before the plans were on paper. You'll be doing that, too, when you sign a contract for your new plant—and you'll have to be *sure* of the qualifications of the firm you hire.

McKee has a long, successful record of sound, practical engineering and construction of projects like yours all over the world. It's the result of accurate analysis and thorough thinking-through of every detail of design, construction and equipment by a well-qualified staff of experienced technical specialists and field personnel.

You can't buy your plant *after* it's built, but you *can* make sure it will be correctly designed and efficiently constructed when you call in McKee.

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York • Tulsa, Oklahoma • Union, N. J. • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto

Only ONE Manufacturer

Supplies all these Condenser Tubes . . .

Yes, that's right! Only Wolverine Tube produces such a wide range of condenser tubes. That's flexibility—the kind that assures the product that's right for the job.

More important to you is the fact that only Wolverine breathes Tubemanship into its products: quality control, imagination, research—the plus values that mean extra-long life, greater efficiency for your installations.

Prime Surface Tubing

On some jobs it is logical to pick a prime surface condenser tube. Because of the varying corrosive conditions encountered, Wolverine produces prime surface tubing in a variety of metals: copper and copper-base alloys, aluminum and electric-welded steel. Naturally, like all Wolverine products, this type of tubing is available in a wide range of sizes.

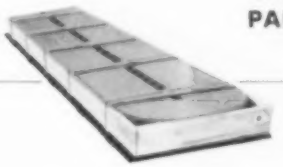
WOLVERINE TUBE

WOLVERINE TRUFIN* TYPE S/T

Frequently it is desirable to pack more heat transfer area into the available space. This is a job for Trufin Type S T—Wolverine's extended surface integral-finned condenser tube. The fins resist the damaging shock of vibration and sudden temperature changes. You can directly replace prime surface condenser tubing with Trufin Type S T—roll or braze it into headers by conventional means. It's available in a variety of metals with four different kinds of end finishing.

WOLVERINE TUBE

U-BEND PALLETS



Either finned or prime surface tubing can be furnished in U-bends—prearranged to your prints. That simply means that the tubes for an entire condenser are shipped on a disposable, box-type pallet. Each U-bend is fed directly from pallet to condenser—a distinct savings of time, storage space, inventories.

WOLVERINE TUBE

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Write today for a copy of the Wolverine book "An Opportunity." It will show you how to cut costs—increase efficiency of condenser units.

*REGISTERED U. S. PATENT OFFICE

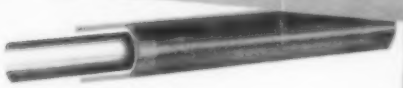
that's Wolverine's FLEXIBILITY

Duplex

PRIME SURFACE CONDENSER TUBING

When two entirely different corrosive conditions are encountered, Wolverine can supply a Duplex tube—one which consists of tubes of two entirely different alloys. For example, the condenser tube illustrated consists of an electric-welded steel tube with a liner of inhibited Admiralty. Any two metals can be used—the determining factor simply being the type of corrosion expected.

WOLVERINE TUBE



Duplex TRUFIN TYPE S/T

Naturally there are applications where only a Duplex tube can be used and yet extra condensing capacity is demanded. That's a job for Duplex S/T. For example, the condenser tube above has a finned copper tube outside and a liner of steel. Combinations like these resist two entirely different corrosion problems. When retubing condensers, Duplex S/T can be easily interchanged with prime surface tube; it has a plain end slightly larger than the O.D. of the fins so that it can be rolled into headers easily. It also has a ferrule of the liner material.

WOLVERINE TUBE

WOLVERINE TRUFIN*

TYPE L/C

There are many applications—air cooling of jacket water, oil, condensing steam or hydrocarbon vapors—where Trufin Type L/C is the answer. This type of condenser tube has a high-finned exterior tube of aluminum and a liner available in a variety of metal to meet your specifications. Trufin Type L/C provides a maximum rate of heat transfer over a long period of operation.

WOLVERINE TUBE

Naturally, the selection of the right type of condenser tube is a tough job—one that's solved only by a complete survey of the job to be done. That's why Wolverine has set up its Field Engineering Service. You get complete help—suggestions on alloys, heat transfer, corrosion problems. That's the type of service that puts you ahead of the game—the type that makes Wolverine your surest source of supply.

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario

*REGISTERED U. S. PATENT OFFICE

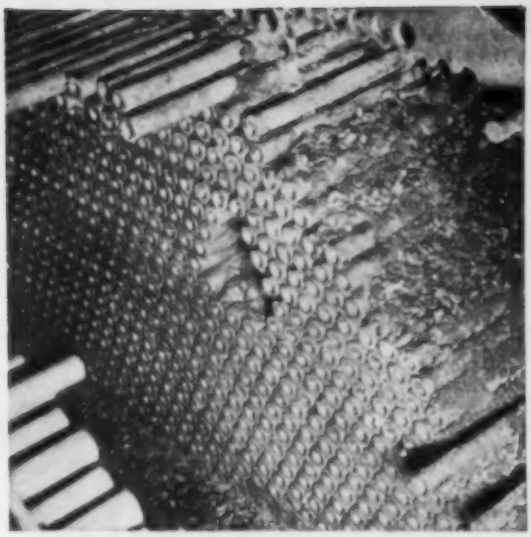
"Heat Exchanger and Condenser Tubes." You can have a copy of this handy book if you write for it on your letterhead . . . today! WOLVERINE TUBE, 1441 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

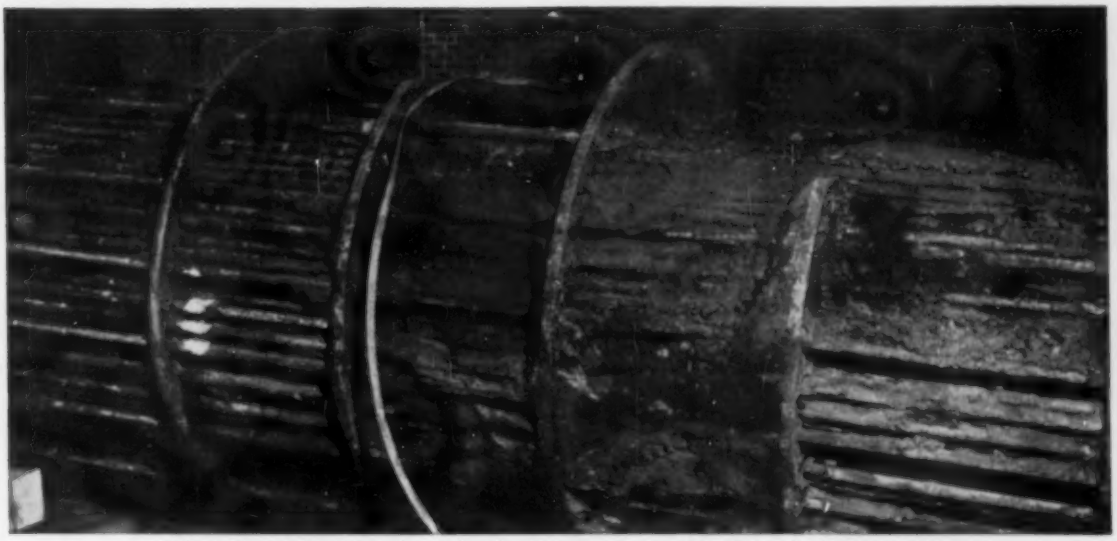
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, N.Y.

POLYRAD STOPS THIS



LOST EQUIPMENT—Cross-section view of a condenser bundle knocked out of service by corrosive attack. Polyrad can help prevent such loss.



LOST TIME—This fouled condenser bundle also cost money to clean. Polyrad's detergent action prevents the formation of organic and inorganic deposits, permits their removal in fluid stream.

There's no longer any reason for frequently cleaning or replacing corroded condenser bundles. Now, through Polyrad's chemical control of fouling and corrosion, this common cause of increased operating costs can be eliminated.

A filming amine inhibitor, Polyrad forms a protective molecular shield that controls the corrosive action of organic and inorganic acids. Throughout the refinery, Polyrad helps maintain throughput, increases heat transfer, reduces metal loss, and cuts down time for maintenance. Fouling is prevented by Polyrad's detergent action, which loosens iron sulfide and other scales to permit their removal in the fluid stream.

Polyrad is readily available from stocks maintained throughout the nation. A Hercules technical representative will be glad to help you evaluate what Polyrad can do for you under your specific operating conditions. For additional data, write Hercules.

Naval Stores Department

HERCULES POWDER COMPANY

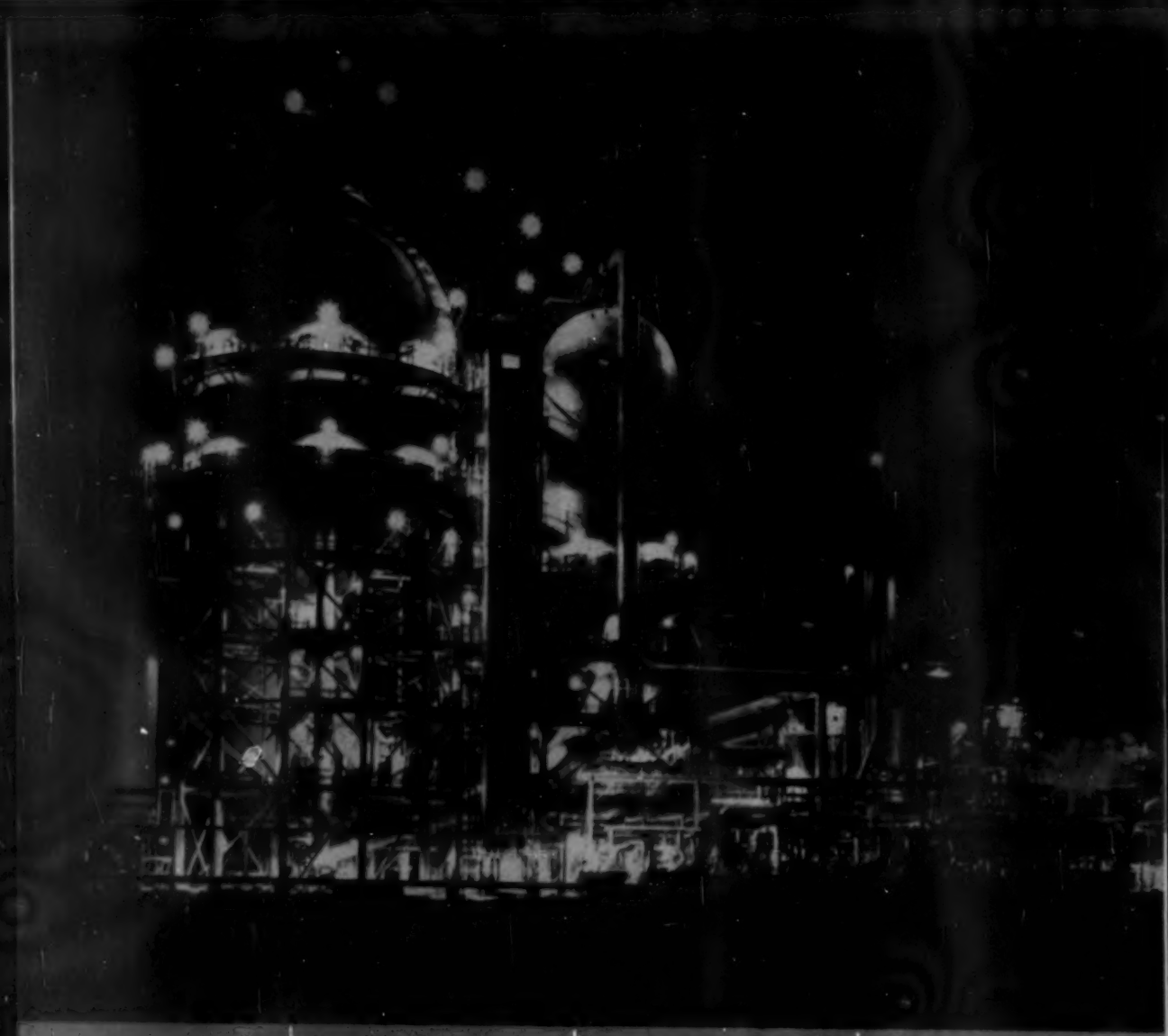
984 Market St., Wilmington 99, Del.

POLYRAD®

FILMING AMINE INHIBITOR

NAS6-7

(To obtain more data on advertised products see page 108)



ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

DRESSER MANUFACTURING DIVISION, Bradford, Pa.—Oil and gas pipe couplings, fittings and sleeves—rolled and welded rings—welded fittings and flanges.

PACIFIC PUMPS INC., Huntington Park, Calif.—Centrifugal pumps, deep oilwell plunger pumps, hot oil and boiler feed pumps.

CLARK BROS. CO. DIVISION, Olean, New York—Engines and compressors—gas, steam and diesel driven.

how the DRESSER PLUS + works for you

In petroleum and chemical plants all over the world, you will find the Dresser *Plus* + in action around the clock. The Dresser *Plus* + is the *plus value* you get when you are served by any of the companies that make up Dresser Industries. Each of these companies operates independently to assure maximum individual attention to your specific problems. Yet all work together to provide an unsurpassed array of research, engineering, manufacturing, and distribution facilities.

At such installations as the Gulf Oil Corporation's huge Catalytic Cracking Unit at Port Arthur, Texas, Clark Blowers help move tons of catalyst through processing chambers, and Clark Compressors handle millions of cubic feet of gas per day. On this same installation, other Clark Compressors are used to provide tons of refrigeration while Pacific Pumps are used extensively to circulate liquid products throughout the unit.

Behind every Dresser product team throughout the oil and chemical industries stands the combined research and engineering experience of *all* the Dresser companies . . . experience that has made Dresser products the *standard of comparison the world over.*

DRESSER INDUSTRIES, INC.
OIL, GAS AND CHEMICAL EQUIPMENT

ATLANTIC BUILDING • DALLAS, TEXAS

IDECO

IDECO, Dallas, Texas—Hydrair Rigs, Rambler Rigs, Masts, Substructures, Shorty Blocks, Swivels, Rotaries, Mud Pumps, general supplies.

Security

SECURITY ENGINEERING DIVISION, Whittier, Calif., Dallas, Tex.—Rock bits, reamers, casing scrapers, reamer rock bits, coring bits, Securaloy.

Magcobar

MAGNET COVE BARIUM CORP., Houston, Tex., Malvern, Ark.—Magcobar and Magcogel drilling muds and other specialized oil well drilling fluids and chemicals.

DRESSER IDECO

DRESSER-IDECO DIVISION, Columbus, Ohio—Radio and television broadcasting towers, steel buildings, aircraft hangars, automatic parking garages.

You a target?

Let's face it . . . we're all targets!

If your plant is not ready with a disaster plan, better act now. There's not a single American plant that's out of range of an intercontinental bomber—and fires, floods, tornadoes or explosions can kill you just as dead as an atom bomb.

It costs next to nothing to take a few simple steps which may save hundreds of lives. Here they are. Check them off today.

☐ **Call your local** Civil Defense Director. He'll help you set up a plan for your offices and plant—a plan that's safer, because it's integrated with community Civil Defense action.

☐ **Check contents** and locations of first-aid kits. Be sure they're adequate and up to date. Here, again, your CD Director can help. He'll advise you on supplies needed for injuries due to blast, radiation, etc.

☐ **Encourage personnel** to attend Red Cross First-Aid Training Courses. They may save your life.

☐ **Encourage your staff** and your community to have their homes prepared. Run ads in your plant paper, in local newspapers, over TV and radio, on bulletin boards. Your CD Director can show you ads that you can sponsor locally. Set the standard of preparedness in your plant city. There's no better way of building prestige and good community relations—and no greater way of helping America.

Act now . . . check off these four simple points . . . lives are at stake . . . have you a right to delay?

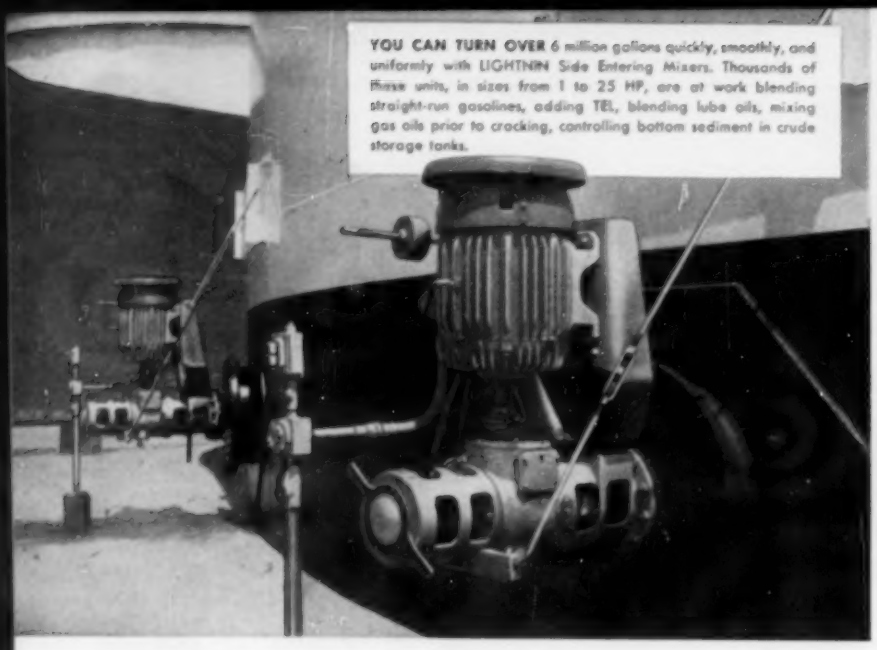
Zallea-designed Expansion Joints assure positive protection from damage caused by pipe movement. The units shown here—gimbal, hinged, and universal types—absorb pipe movements in any direction, imposing minimum forces on adjacent piping, equipment and anchors. An original Zallea development, gimbal expansion joints permit angular movement in any plane, with gimbal ring and hinges built to withstand pressure thrust and to support piping.

Zallea already has, or will design, expansion joints for every service—and to suit any piping layout. Test records show that Zallea Expansion Joints outlast all other packless joints by as much as 1800%. For information on standard types, or consultation on special expansion or piping problems, ask to have a Zallea representative call.

Zallea *expansion joints*

ZALLEA BROTHERS, 822 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints



YOU CAN TURN OVER 6 million gallons quickly, smoothly, and uniformly with LIGHTNIN Side Entering Mixers. Thousands of these units, in sizes from 1 to 25 HP, are at work blending straight-run gasolines, adding TEL, blending lube oils, mixing gas oils prior to cracking, controlling bottom sediment in crude storage tanks.

How to be on safe ground when you plan for fluid mixing

A refinery engineer recently found he had been allowing two hours for a mixing operation that, when correctly done, took 15 minutes.

Why take chances with fluid mixing—when it's so easy to *be sure* you're right?

You can get the right data-answer for *any* fluid mixing problem—quickly, without cost or obligation—by handing the problem to your LIGHTNIN Mixer representative.

He eliminates guesswork and risk, by giving you an unqualified guarantee of *successful results.*

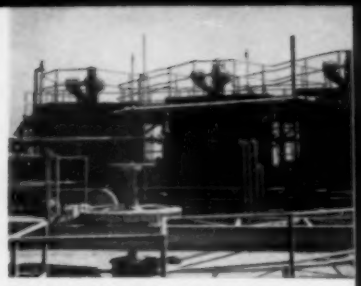
His approach to your problem is sound, fundamental—yet fully in step with today's processing methods.

His recommendations are based on 25 years of research and field experience on thousands and thousands of applications.

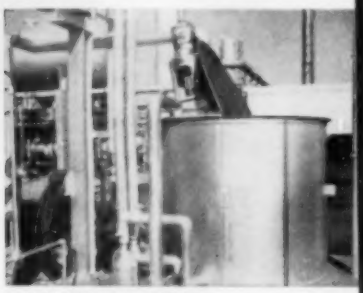
Save on upkeep, too

He can show you the way to maintenance savings you may never have thought possible with fluid mixers. A sensible program for reducing machine obsolescence, and keeping replacement costs low.

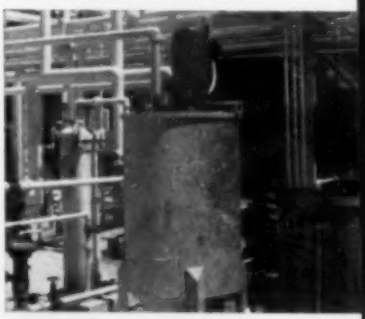
Before you select a fluid mixer for *any* purpose, find out how much time and effort you can save by checking first with MIXCO. Get the facts now on the LIGHTNIN guarantee that protects you unconditionally. Call in your LIGHTNIN representative—or write us today.



CAUSTIC TREATING and other mixing jobs become fast, efficient operation with turbine-type LIGHTNIN Mixers. You can mix, blend, suspend solids, get intimate gas-liquid and liquid-liquid contact, in open tanks or closed pressure vessels with these units. Standard sizes from 1 to 500 HP provide hundreds of power-speed combinations.



FOR TANKS up to 3,000 gals., continuous or batch mixing, pipeline mixing, there are 30 LIGHTNIN propeller-type models to choose from. Sizes ¼ to 3 HP.



OPEN TANK becomes an efficient mixing vessel when you add a LIGHTNIN Portable Mixer. Over 30 models, electric or air driven. Sizes ½ to 3 HP.

- ☐ DH-50 and DH-51 Laboratory Mixers
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air driven)
- ☐ B-502 Mud Mixers (oil well drilling)
- ☐ B-503 Mixers for BS&W Control

MIXING EQUIPMENT Co., Inc.

131-a Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ontario.

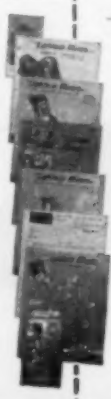
Please send me, without obligation, catalogs checked at left.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

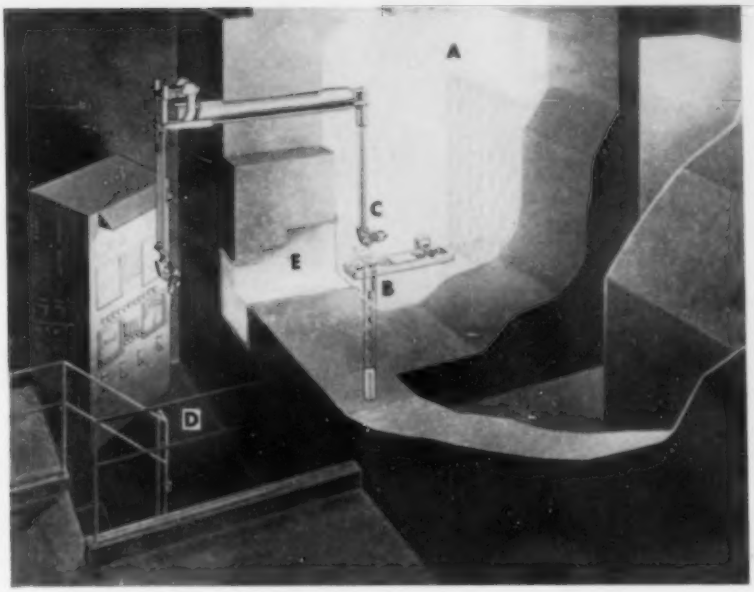


"Lightnin® Mixers"

GET THESE HELPFUL FACTS ON MIXING LIGHTNIN Catalogs contain practical data on impeller selection, sizing, best type of vessel, installation and operating hints, full description of LIGHTNIN Mixers. Yours without obligation. Check and mail coupon today.

MIXCO fluid mixing specialists

Petroleum Processing
JANUARY 1955



"HOT STUFF" could well be the nickname of this $250,000 laboratory Standard Oil Development Co. is building to study the application of gamma radiation to refining and petrochemical processes. This artist's sketch of a part of the lab shows the cave "A" where the radiation work will be done, the well "B" in which the source of radiation (a piece of cobalt pipe) will be stored, one of two mechanical hands "C" for handling the cobalt from outside the cave, the operating pit "D," and a lead glass window "E" over 3 ft. thick for observing experiments.

Atomic Energy a Process Tool?

Standard Oil Development plans to spend about $1,000,000 in next five years to find answers

By WILLIAM F. BLAND, Editor

THE largest private laboratory for studying how atomic energy might be used to promote petroleum processing reactions is now under construction. It is being built by Standard Oil Development Co. (research affiliate of Jersey Standard) at its Esso Research Center at Linden, N. J., and is scheduled to be in operation in April of this year.

Gamma rays—emitted from radioactive cobalt—will be used as the source of energy for the studies.

Total cost of the new facilities is expected to be about $250,000. In addition, S.O.D. expects to invest upwards of $1-million in operating the laboratory during the next five years. Initially, the research staff will consist of four or five scientists trained in the field of radioactivity. Most of them are persons who have been with S.O.D. for some time, and were sent outside for the necessary specialized training.

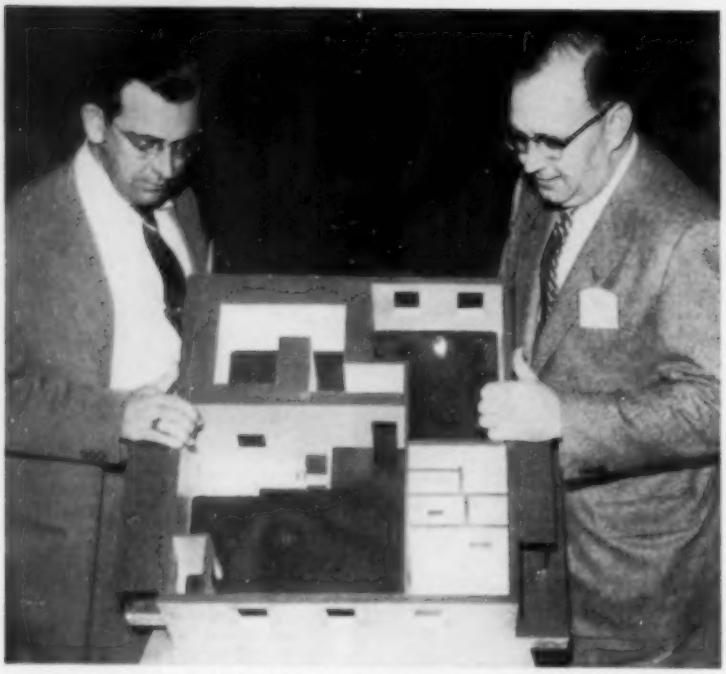
According to Eger V. Murphree, president of S.O.D., the new laboratory will be the first privately financed radiation laboratory of anything like this magnitude in the world petroleum industry, and should make possible the most intensive research effort of its type in the oil business.

The decision to build the laboratory followed two years of research by company scientists utilizing gamma radiation facilities at the Brookhaven National Laboratories at Upton (Long Island), N. Y. Results of that preliminary work, although S.O.D. officials would not reveal the extent of results of the studies, apparently were sufficiently promising to warrant the present venture.

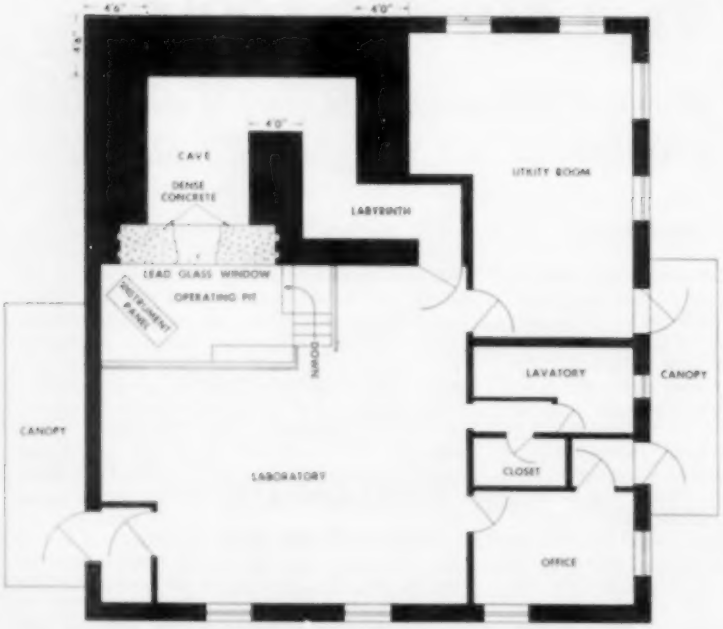
Scope of the research to be carried out in the new laboratory will be strictly exploratory—at least at the start. Studies will be directed toward answering two major questions:

1—How does gamma radiation influence the chemical reactions involved in petroleum processing operations—both refining and petrochemical?

2—What is the best way of applying gamma



MODEL OF THE LAB which S.O.D. is building to study radiation as a processing tool is being checked by James F. Black (left), one of the researchers who will use the facilities, and Charles L. Fleming, director of the Research Division of S.O.D.



PLOT PLAN of the laboratory—which will be one-story affair, 42 ft. by 46 ft. It is being built as part of the Esso Research Center at Linden, N. J., rather than in an isolated spot—an indication of how safe S.O.D. officials believe the work to be

radiation to influence any such reaction?

The new laboratory will be devoted entirely to process research—how to use gamma radiation to initiate or promote manufacturing operations. It will not be concerned with investigations of the use of radioactive materials as tracers, techniques which have been under development and in use in many laboratories and plants in the industry for a number of years.

Initial investigations will probably be concerned with polymerization, since some work has already been done on this process in other laboratories, particularly at the University of Michigan. Also, this is one process S.O.D. admitted to having studied in its preliminary investigation at the Brookhaven laboratory.

What this work might lead to is still pretty much a matter of conjecture. But researchers in the S.O.D. labs who are close to the subject state that it is their feeling that radiation has wide potentialities for starting up reactions which can't be initiated with any other conventional means.

In general, it is thought gamma radiation is capable of imparting tremendous quantities of energy to a molecule—sufficient to break chemical bonds which are otherwise stable. Esso researchers are approaching radiation not so much as a catalyst but more as an initiator—"something which can be used to overcome the initial inertia to a reaction taking place."

This might also mean that radiation could become a fourth process tool—in addition to heat, pressure, and catalysis. With radiation applied to a process, for example, it might be possible to achieve the same desired results at low temperatures or pressures, or without the use of a catalyst. Or radiation might make it possible to control a reaction more closely, to speed it up, or to change the character of the end products.

Esso researchers aren't willing to speculate on what practical results—if any—may eventually come from this work. But it takes only a little imagination for a petroleum technologist to see the tremendous revolution which could take place in catalytic cracking, for example, if gamma radiation could be applied to do the same job. You would not have to be concerned with catalyst movement, separation or regeneration—although you might well be faced with other problems of an as yet unknown nature.

Source of the gamma radiation at the S.O.D. research unit will be a piece of radioactive cobalt, in the form of a 13-in. length of pipe, 2 in. in diameter. This radioactive cobalt is being pur-

chased from the Brookhaven National Laboratory, where it has been undergoing neutron bombardment in an atomic pile for over 2½ years. Its cost will be in the neighborhood of $17,000 to $18,000.

By the time the cobalt is moved to the new radiation laboratory in April it will have a strength of from 3,500 to 4,000 curies. (A curie is approximately the amount of radioactivity given off every second by one gram of radium — making the cobalt pipe equivalent to about 8 lbs. of radium. Total world supply of refined radium represents an estimated 2,400 curies.) It will be the most radioactive single piece of cobalt known, although stronger sources in the form of a grouping of a number of less radioactive cobalt rods are said to be in use in government-sponsored research activities.

The pipe will be covered with a thin sheathing of aluminum—about 1/16 or 1/8 in. thick. Its purpose will be to prevent scuffing of the cobalt during handling, and the possibility that particles of radioactive material might be scraped off on the apparatus. Although the sheathing has been on the cobalt all the while the latter has been in the Brookhaven reactor, aluminum does not become dangerously radioactive, so there is no danger if a portion of the sheathing should be scraped off.

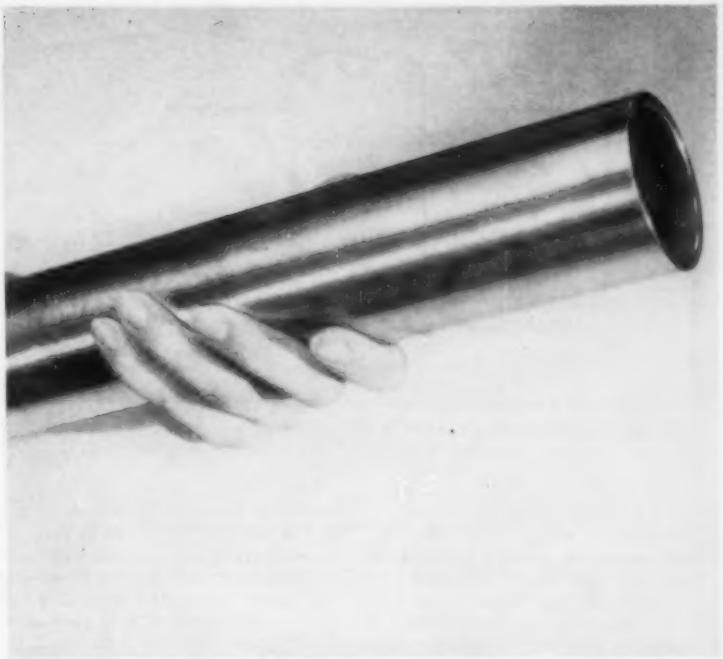
Cheaper and stronger sources of radiation are seen as one of the problems which must be solved before any commercial application of radioactivity to petroleum processing would be feasible—and Esso scientists are of the opinion that they are potentially available.

One such anticipated source includes the radioactive byproducts of atomic reactor operations which the Atomic Energy Commission presently stores underground until their radioactivity decomposes.

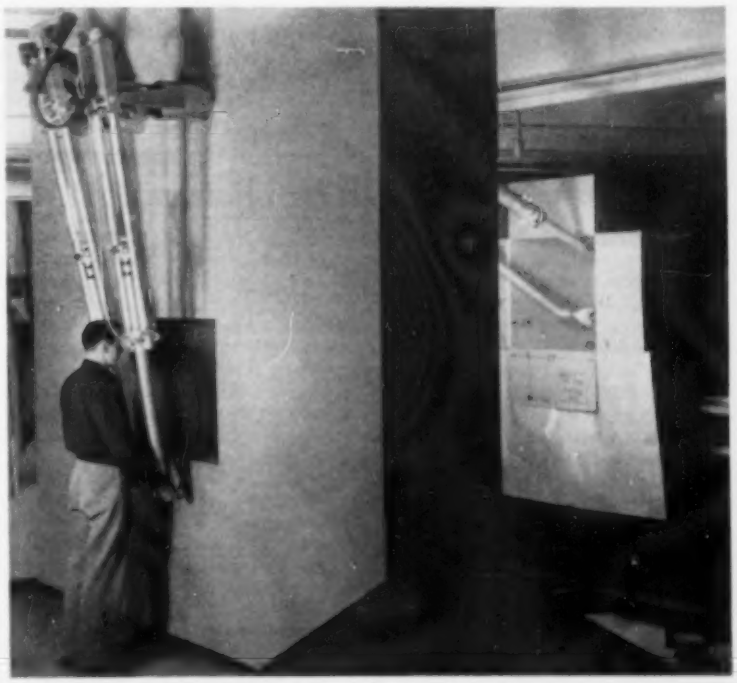
Another possibility would be to utilize the gamma rays produced in an atomic reactor and now dissipated into shields surrounding the reactor. The latter course might even call for the installation of an atomic reactor as an integral part of a petroleum processing plant.

The laboratory S.O.D. is building will be an entirely new one-story structure, 42 by 46 ft. It is being built as part of the Esso Research Center group at Linden—not in an isolated location.

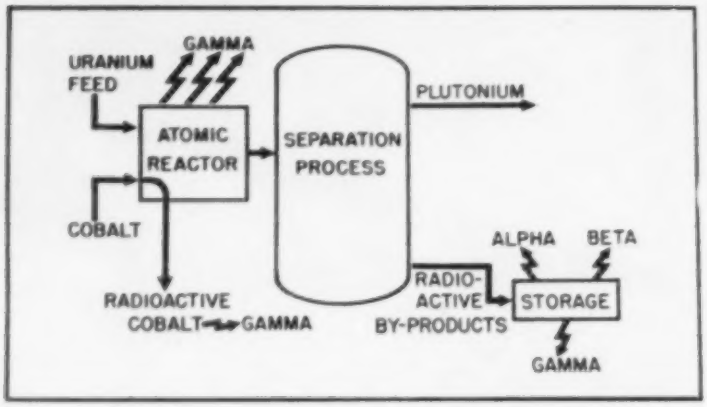
As shown in the plot plan, it will include a "cave" or reaction section, an operating and observation pit, laboratory for preparing reactor equipment setups, and other auxiliary facilities. The cave will be the heart of



SOURCE OF THE RADIATION in the new S.O.D. lab will be a 13-in. length of radioactive cobalt pipe, similar in appearance to this piece but much too hot to handle. It will have an initial strength of 3,500-4,000 curies, the result of neutron bombardment in an atomic reactor for over 2½ years



MECHANICAL HANDS similar to this demonstration pair will be used for all handling of the radioactive cobalt. Known as master-slave manipulators, they reportedly are so sensitive that the operator can actually "feel" when the object being handled is set down



HOW ESSO'S RADIOACTIVE COBALT IS PREPARED in an atomic reactor (not by the oil company) is shown in this schematic diagram

the laboratory. This is where the source of gamma radiation—the radioactive piece of cobalt pipe—will be used. The cave will be a room 6 by 9 ft., having a concrete roof and walls up to 4½ ft. thick. This thickness of concrete is necessary to stop the radiation from penetrating to the surrounding area.

Since a door comparable in density to that thickness of concrete would be tremendously bulky and cumbersome to handle, access to and from the cave will be through a labyrinth as indicated in the plot plan.

Except when in use in an experiment, the radioactive cobalt will be stored in a well in the cave floor. This well will be covered by a thick lead cap, which will be locked in place by a steel bar.

Researchers will be able to see into the cave from the operating pit through a window of lead glass about 3 ft. square and over 3 ft. thick. Because of the high index of refraction of the glass, practically the entire interior of the room will be visible through this window.

While looking through this thick window, the operators will be able to handle the radioactive pipe and other objects inside the cave with a pair of mechanical hands known as master-slave manipulators. This will be the first use by private industry of these devices, since all others manufactured to date are being used on AEC projects and contracts. Using these mechanical hands, it will be possible to place the pipe up against laboratory apparatus and small pilot plants which contain petroleum materials to be subjected to radiation. Small samples can be placed inside the hollow pipe for concentrated treatment.

The cave will be highly instrumented and provided with facilities for controlling reactor conditions — particularly for low temperature operations.

Extensive safety precautions are being employed in the new laboratory to minimize the possibility of danger—both to the research workers on the project and to the surrounding area.

Since the radioactive cobalt does not cause other objects to become radioactive, there is no possibility of air or water pollution. Likewise, the cave itself and all the material and equipment exposed to the cobalt during an experiment are perfectly safe once the cobalt has been removed to its well and shielded with the lead cap.

The only danger exists in the possibility of direct exposure to the radiation from the cobalt. The thick concrete walls and lead glass observation window will effectively prevent any such exposure when the cobalt is in use in the cave. A system of interconnected locks will prevent entry to the cave except when the cobalt is safely stored away in its well and shielded.

All handling of the cobalt will be done remotely, with the mechanical hands. These are designed and installed in such a manner that they can be withdrawn from the cave for repairs (through their respective access holes) even while the cobalt is in use.

Should the mechanical hands become completely inoperative, or should the cobalt pipe get loose and in such a position that it can't be recovered with the hands, there is still an "out." The thick roof of the cave, as indicated in the sketch above, is equipped with a large plug. The room can be sealed off and flooded with water, this plug removed, and the pipe recovered and returned to its well with the aid of grappling devices operated through the hole in the roof. The water will provide sufficient shielding for the time involved.

There's another safety factor—the Atomic Energy Commission. Although the Commission will have no control over the laboratory itself, one of the conditions under which the radioactive cobalt is being made available is that members of the AEC may visit the laboratory at any time to satisfy themselves that proper procedures are being followed in the handling of the cobalt.

Atomic Energy Old Hat Now at S.O.D.

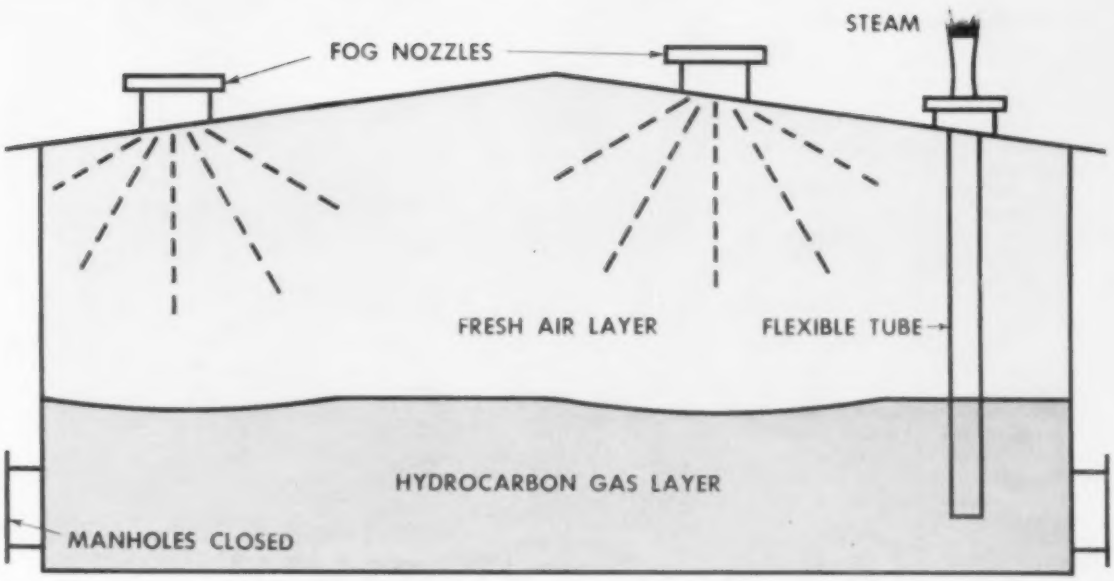
EXPLORATION work in the possible peacetime applications of atomic energy is not exactly a brand-new story for Standard Oil Development Co. Back in 1938, when uranium was a mining by-product, S.O.D. scientists investigated the use of the metal in promoting chemical reactions, as a corrosion preventative, and other possibilities.

In 1941, work was begun on a process for the large-scale production of heavy water, an important component of the atomic reactor. S.O.D. has a consulting contract on heavy water with the Atomic Energy Commission at the present time.

In 1942, the company undertook the construction of a pilot plant to obtain the fissionable variety of uranium known as U-235. This must be separated from another variety, U-238, which has the same chemical properties and about the same atomic weight but is non-fissionable. There is only one part of U-235 for every 139 parts of U-238 in natural uranium.

In this pilot plant the company was able to demonstrate effectively that this separation was possible on a large scale by what was called the "centrifugal method."

Through a contract with the AEC, the company also developed equipment and techniques applicable to the separation of plutonium from the many radioactive elements formed when uranium fissions in a reactor. Since the natural radioactive isotope U-235 is relatively scarce, the manufacture and separation of plutonium are, from a long range viewpoint, most important to peacetime use of atomic energy.



FAST AND SAFE is this vapor-freeing technique; little turbulence exists with roof-mounted eductor and fog nozzle guarding air inlets. Vapor leaves from bottom.

Want Gas-Free Storage Tanks?

You can have them in one hour by using this safe and relatively inexpensive technique

By D. P. THORNTON, Jr.
Southwestern Editor

CONTINUED experience with a new method of gas-freeing storage tanks developed at Shell Oil Co.'s Norco, La., refinery has resulted in considerable new data and some modifications in practice from the original procedure reported in this magazine two years ago.[1]

The procedure involves withdrawing tank vapors via an eductor from near the bottom and admitting air to enter at the top through a curtain of water fog. (See drawing above.) A minimum of turbulence and mixing is thereby created. Since most hydrocarbon vapors encountered in storage tanks are heavier than air, they tend to remain as the bottom layer.

Vapors are most difficult to purge in the case of pressure distillate bottoms, pressure distillate, gasoline, and crude oil, all of which are refinery materials customarily stored. Of these, crude oil is cited as the worst because of the usual presence of pyrophoric iron sulfide deposits which constitute a potential fire hazard when exposed to oxygen.

Experience with the new method, using eductor-and-fog nozzle, indicates however that regardless of the material, most tanks will have been purged so that the atmosphere is at least 50% below the explosive limit within one hour of the time purging commenced.

Moreover, vaporization from deposits stirred up during cleaning will be removed nearly as rapidly as liberated if purging is continued. Hydrocarbon vapors thus will not accumulate in sufficient amount to constitute a fire hazard or produce toxic effects upon inhalation by workers.

The method differs from customary tank purging as follows:

1—One or more eductors of suitable size, equipped with collapsible tubes, are installed on appropriate tank roof openings. Eductors may be steam, air or power operated; steam-operation preferred for safety reasons.

2—Collapsible tubes are lowered to within a foot of tank bottom or liquid surface.

3—Fog nozzles are installed on remaining tank roof openings of suitable size to force all air entering tank to pass through fog curtain.

4—No other openings are made in the tank roof and none whatever in the shell until purging is completed.

5—Purging time is limited only by vapor-handling capacity of either eductor(s) or roof openings admitting fresh air.

6—No personnel attention is required once purging is started. Area may be evacuated if desired.

The method essentially uses steam- or air-powered eductors, mounted in the tank roof openings, and carrying collapsible fabric tubes lowered to within a foot of tank bottom or the surface of any remaining liquid. This assures withdrawal of vapors from near the bottom of the tank.

Purge air is admitted to the tank via remaining roof openings. In each case these openings are equipped with fog nozzles so placed that all incoming air

must first pass through the fog curtain before entering the tank. The air is thus saturated for all practical purposes and the water supply to the nozzles may be heated if necessary to assure this.

All shell openings are kept sealed until purging is completed, as determined by gas-meter test to a value below 50% of the lower explosive limit for the contents of the tank. This avoids diffusion and turbulent mixing of tank vapor with purge air to create an explosive mixture and precludes the possibility of creating "pockets" of vapor.

How does it compare with steam as a means for making tanks safe? The case against steam-purging of tanks, and steam cleaning also, is strong. Norco's personnel are so impressed that they have decided never again to steam-purge. Their reasons can be summed up best from expressed views of Norco's Engineering and Safety & Fire departments, as follows:

1—Eductor-and-fog nozzle purging with adequate equipment requires one to two hours maximum. Steam purging a large tank rarely is complete in less than 24 hours and may require up to two days.

2—The explosive mixture hazard is greatly reduced with the "new" method in comparison with steam purging, if for no other reason than because of the much shorter time during which an explosive mixture could exist.

3—Out-of-service time is shorter than with steam purging and less steam (air or power) is consumed.

4—Close supervision is required with steam purging to prevent damage to a tank from bursting or collapse, and injury to men from burns. No personnel are required in attendance once purging commences with the "new" method; the tank cannot burst and there is no danger of collapse from sudden atmospheric temperature changes or thunder showers.

5—The tank must be allowed to cool following steam-purging before men can enter. The tank is as cool as it ever will be immediately following purging with the eductor-and-fog nozzle method. Eductors also provide ventilation during the work period; prevent vapor accumulations as cleaning proceeds.

Applying the Method—The eductor now used at Norco is a "Type ST 2100 'Steam-EX'" 16-in. eductor, available from Shand and Jurs Co. at a cost of approximately $250. When supplied with 75 psi. saturated steam, the consumption is 900 lbs./hr., and vapor-moving capacity is 300,000 SCFH. The collapsible tube—trade-named "Spiratube"—is 16 in. in diameter, 25 ft. long and has a 3-ft. adapter to permit attaching the assembly to the manway flange or other opening with quick-operating clamps.

1 Eductor comes in three parts for ready portability . . .

4 . . . But extended as if in service in the tank, Spiratube looks like this . . .

The flexible tube is equipped with a sash-cord attached to the bottom ring of the tube and long enough to extend beyond the adapter when the tube is fully extended. Weights are provided for attachment to the bottom ring of the tube. By means of the cord arrangement, the tube can be extended so that the bottom ring is approximately a foot above tank bottom or liquid surface.

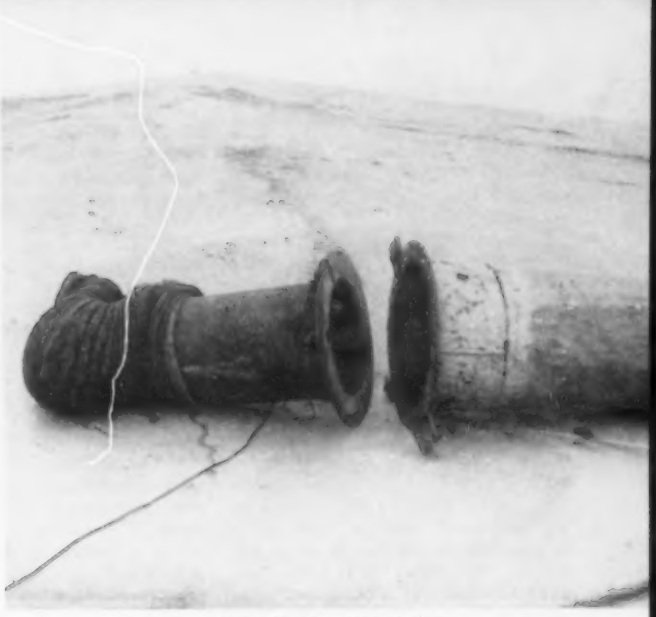
The eductor is brought to the top of the tank in three sections. It is assembled by quick-operating clamps and attached to the adapter on the Spiratube, then connected to the steam or other supply.

Any good fog nozzle may be used. It should be positioned so that the area of the opening into the tank is completely covered by fog when all nozzles are turned "on." In cold or snappy weather it may be desirable to warm the water supply to the nozzle (up to 100°F is sufficient) with steam if the water temperature is very low.

The general procedure is not greatly different from conventional tank-purging operations using eductors. Current practice calls for placing the fog nozzles on the largest openings in the tank roof and, usually, all openings suitable for fog nozzles and eductors are equipped with them, regardless of tank size.

Make sure there's enough air inlet area in the tank roof. This precaution should always be observed and

2 . . . And looks like this when assembled with quick-operating bolts . . .



3 . . . Ready for attaching to flexible tube, shown collapsed . . .

5 tube is installed and bottom end is being lowered to desired position in tank. Eductor is ready for installation

6 Eductor now installed, vapor is being sucked from tank at 300,000 cfm.

is especially important with small tanks having limited manway openings in the roof. Otherwise, it is possible that the eductor could pull enough vacuum to cause collapse of the tank—similar to the effect a sudden shower might have upon a tank filled with steam. A good rule of thumb now being followed is to provide an absolute minimum of twice as much air inlet area (protected by fog nozzles) as there is total eductor area. If necessary, the steam supply to the eductor should be regulated to or below rated input. Norco personnel prefer to supply adequate air inlet area rather than regulate steam.

The condition of the tank itself always should govern the eductor rate (steam pressure) as a final caution. If the tank is in bad shape, it is far preferable to take a longer time to purge than risking collapse by excessive vacuum.

In this connection, it so happens that Shell customarily specifies a larger number of roof openings for various equipment than is common in the industry and also requires a bottom drain. Other plants adopting this procedure therefore may not find it possible to use as many fog nozzles or eductors as is called for in Norco practice.

High speed in purging to acceptable safety standards is a feature of the new method. Tables 1 and 2 show the time required for purging tanks ranging from 38,000 to 77,000 bbls. capacity, the contents of which represent most products commonly stored.

Table 1 gives elapsed time from start of purging until initial inspection of the tank atmosphere by the Safety Department, using one eductor with Spiratube and fog nozzles protecting the two air inlets. In all cases the atmosphere found in the tank when tested contained less than 50% of the lower explosive limit of the product which had been stored.

Table 2 shows the actual time required to vapor free the storage tanks listed to below 50% of the lower explosive limit. In this series, two eductors and four fog nozzles were used.

For comparison, here are two cases reported by an oil company other than Shell Oil Co. which indicate the comparative time for purging by steaming and with air-movers. Both used 6-in. "Lamb" air movers (Mine

Safety Appliances Co.) rated at 3150 cfm. of air with steam (or air) supply of 70 psi. Air movers were roof-mounted with air inlet from a shell manhole.

Refinery "A" found it took 24 hours to gas-free a 35 x 42-ft. tank using conventional steaming procedures. Steam consumption was 9000 lbs./hr. In comparison, using a Lamb air-mover, a ventilation rate of 3150 cfm. reportedly was secured. The tank was purged in five hours; steam consumption is not stated.

Refinery "B" of the same company found it required 35 hours to steam-purge a 50 x 42 ft. tank; consumption is not reported. Using an air-mover on the same tank required 13½ hours to purge it; steam rate is again unstated. The report adds that "undoubtedly the tank would have been found to be gas-free in less time than reported if there had been opportunity to make an earlier gas test."

In no case reported by Shell's Norco plant was more than four hours required with one eductor, although the eductor used had nearly twice the vapor-moving capacity of the Lamb mover used by the other oil company.

Based on the probably more realistic rate data of Table 2, one hour would have been ample time for even the largest tank using one Shand & Jurs eductor. Also, it is likely that had the Norco procedure been used by the other oil company, tanks could have been purged acceptably in approximately two hours instead of the five hours reported for the one tank. Shell's arbitrary one-hour limit before making any gas test would appear adequately conservative.

Industry Comments: Following publication of the first article on this subject[1] a number of comments and tentative objections to the method as reported were made by various oil company representatives to PETROLEUM PROCESSING. Insofar as possible this article will attempt to answer these objections and to explain more fully those points of the original article which appeared to have been misunderstood.

Steaming tanks not only is time-consuming and perhaps more hazardous than other methods, but also expensive, according to several of these authorities.[2, 3, 4, 5] They, and others, have shown that unless the tank is heated to at least 170°F. it is doubtful if hydrocarbon vapors will be purged regardless of how long blowing with steam is continued. There is in addition the possible ignition hazard from static sparks during this period.

The use of steam or air-powered eductors, or mechanically driven blowers (providing proper precautions are taken to make the latter safe for use in hazardous atmospheres) is becoming quite common.

Eductors are roof-mounted and shell manholes are opened during the purging period. Blowers may be either roof- or shell-mounted, depending on design.

Sluze[5] mounts the air-mover on the tank roof and opens one or more shell manholes, but comments that his company often has considered using canvas or aluminum tubing on present air-movers. However, he added that, since tanks can be consistently gas-freed "in a matter of hours" anyway, in comparison with one or more days by steaming, the matter has been given no further consideration. This authority, probably not alone, also regards use of fog nozzles as hazardous, contending that they are "an ideal way of generating static electricity." He points out that the only practical approach to handling iron sulfide, in his opinion, is by keeping it wetted down.

Objections Answered: One of the principal objections to the method described in the earlier article was the apparent "clumsiness of the eductor and Spiratube assembly."

This is not the case as accompanying photographs will help show.

3 Case Histories of Norco Results

ACTUAL cases taken from Shell's Norco refinery records show the rapidity with which tank purging can be accomplished and the flexibility of the new method when "hurry-up" jobs are involved.

1—Routine Cleaning, Repair

A 72,000-bbl. gasoline tank was scheduled for extensive shell repairs, involving welding to attach external patches over leaks. The cleaning crew was advised by the operating department that the tank had been pumped out and was ready for cleaning and repair.

Sixty minutes were required for the following operations:

1—Set and hook up two eductors with Spiratubes.

2—Install and hook up four fog nozzles.

3—Float off free gasoline from tank bottom with water and pump out.

4—Blind tank nozzles, wash out and blind off all pipe connections to tank except foamite and drain lines.

5—Safety Department inspection of the above operations.

Purging then commenced.

Two hours from the time purging commenced, or three hours from the time the tank was released from service by the Operating Department, repair men were at work on the tank. Welding and repair operations required eight hours more, during which time ventilation via eductor continued. Immediately upon completing repairs the lines were reconnected, eductors and fog nozzles removed and tank was approved for return to service.

Total elapsed time was 12 hours from release from service to return.

2—Emergency Repair

A 55,000-bbl. gasoline tank was taken from service because of a broken swing-line. Immediate repair was urgent.

Installing purging apparatus as previously described, purging and the repair operations required between six and seven hours. It was not necessary to clean the tank.

3—'Hurry Up' Job

Swing-line floats needed revision on a 55,000-bbl., light fuel oil tank and to avoid complications elsewhere the operating department could allot two days only for the work.

Only one eductor and two fog nozzles were available for purging operations, due to work in progress elsewhere in the plant. Since the tank did not require cleaning it was decided to try to make the deadline.

Gas-freeing operations as previously described commenced at 8 a.m. At 10 a.m. a work permit had been issued and the float-repair crew was at work. Revision completed and work certified, the tank was returned to service considerably ahead of the time it had to be available.

Approximately 58 tanks have been opened and purged for cleaning and repairs using this method, without untoward incident. Tank sizes range from 37,000 to 92,000 bbls. and contents represent the gamut of product and crude storage in a modern refinery.

Weighing but 45 lbs. in its carrier, the Spiratube is carried to the top of the tank in the carrier and represents a bundle of approximately 18-in. diameter and 3 ft. long, readily carried by one man. The adapter may or may not be permanently connected: if it is connected, the package still is neither clumsy nor heavy.

One or more men remove the tube from the carrier, keeping it collapsed, and by means of the sash cord and weights previously described, put the tube in place on the roof opening flange and extend the tube the desired distance.

The eductor is separately brought to the roof in three sections, all readily portable, and assembled. It is lifted into place atop the Sipratube adaptor and attached with quick-operating clamps. Connection to steam supply is made with flexible hoses.

At Norco, the safety representative starts tank purging, although this is not required by safety rules. His first job is to inspect the preparations, after which he directs all personnel to evacuate the work area until further notice.

It is the practice for the safety representative personally to open the water lines to the fog nozzles and assure himself that the area of the purge-air opening into the tank is completely covered by fog. Then the steam to the eductors is gradually opened over a five-minute period until operating at capacity. The safety man then also leaves the area, to return an hour later to make the first atmosphere test. If it meets specified safety requirements (50% of the lower explosive limit), a work permit is issued, the fog nozzles are turned off and cleaning is commenced. Purging cannot be stopped until a gas test is made and a work permit issued.

The eductors continue in operation during cleaning and repair work to remove any vapors which may be stirred up when deposits are disturbed and, most important, to provide fresh air to the workmen. Sometimes on large tanks an eductor may be dismounted from the Spiratube and remounted on a shell manway to improve ventilation to the men by creating a turbulence to dispel the stratum of warm, moist air which tends to form when eductors equipped with Spiratubes alone are used for ventilation. This is not necessary on small tanks.

Little turbulence and mixing of hydrocarbon vapors with air exists, avoiding an unusually hazardous condition. The opposite of this condition was feared by several commenting authorities, and apparently is an unfortunate misconception stemming from the original article. Actual observations, some of which were undertaken subsequently at the author's request, confirm that turbulence and mixing of vapors with purge air occurs only for a few minutes immediately following initiation of purging.

Table 1—Elapsed Time to Purge Storage Tanks With One Roof-Mounted Eductor*

Capacity, Bbls.	Contents	Time,** Hours
55,000	Light Fuel Oil	2
38,000	Gasoline	3
55,000	Light Fuel Oil	1½
55,000	Sweet Crude Oil	4
55,000	Light Fuel Oil	2
55,000	Gasoline	4
55,000	Gas Oil	1½
77,000	Gas Oil	2
38,000	Kerosine	1½
38,000	Pressure distillate	2½
72,000	Gasoline	1***

*Eductor of 300 MScf./hr. capacity.
**Elapsed time to first inspection, when found gas-free.
***Two eductors.

Table 2—Actual Purging Time With Two Eductors*

Capacity, Bbls.	Contents	Time, Minutes
55,000	Gasoline	28
72,000	Gasoline	37
55,000	Gasoline	32

*300 MScf./hr., roof-mounted.

Stratification rather than turbulence exists, despite the entry of air at relatively high velocities through the roof openings. Several tests with explosion meters confirm this. Tests were made from gage hatches of cone-roof tanks, near a point where the shell connects with the roof. Position of eductor and air inlet are indicated in the drawing.

The first test, on a 55,000-bbl. gasoline tank, showed a definite interface existing within eight minutes of the start of purging with one eductor. Pure air overlay the vapor-laden tank atmosphere. The interface dropped steadily for the limited time observations continued. Thirty-two minutes from the start of purging, the tank was found vapor free, but purging continued and men were not allowed to enter the area until the tank has been purged one hour.

During this test, the observer did not remain continuously on the tank. Thus it is improper to conclude that the interface reached the tank bottom 32 minutes after initiation of purging. It is believed that this occurred an appreciable time previously, but rate data were not taken.

The second test was made on a 72,000-bbl. gasoline tank equipped with two eductors. When purging first started there was definite evidence of turbulence and mixing of fresh air with tank vapors. This subsided in approximately three minutes from start of purging. A definite pure air-tank vapor interface was found three feet below the top of the shell six minutes after purging commenced.

The third test was made on a 55,000-bbl. gasoline tank equipped with two eductors. The first check was made 20 minutes after purging was started and a definite interface was found 20 ft. below the top of the shell.

No doubt turbulence and some mixing of tank vapor with purge air occurs immediately upon the inception of purging. A simple measurement in the case of the two 55,000-bbl. tanks will show that the flow of vapor out of the tank will range between 1500 to 2000 ft./min. A corresponding inflow of purge air also occurs.

But, these velocities occur only at the exit from the eductor and the flange of the roof inlet. Down inside the tank, an appreciable distance from the air inlet, it has been calculated that the purge air velocity drops quickly to approximately 0.5 ft./min. This is hardly enough to create much turbulence although, if a profile of the interface could be plotted, it probably would be concave under each air inlet.

Further evidence of stratification is contained in reports by workers during cleaning operations. These men invariably report that a layer of warm, "muggy" air persists on the bottom of a large tank long after the use of fog nozzles has been discontinued, although eductors continue to operate. Also, they report a layer of cool air close to the cone roof of the tank and that an appreciable "line" exists between these two layers.

This is the reason why an eductor (usually just one) is moved to a shell manhole on large tanks after the vessel has been satisfactorily purged: to set up turbulence and pull cool, fresh air into this bottom layer to improve the comfort of personnel during cleaning.

Increased turbulence and mixing and greater possibility of leaving pockets of vapor in the tank are invited by side-entry of purge air, Norco personnel believe.

If air enters at the bottom of the tank, there is little doubt that air and hydrocarbon vapor will mix due to turbulence and the fact that the

air is pushing the vapor out of the tank.

With this turbulence it is certain that the hydrocarbon-air mixture which results will be, at some time during purging, within the explosive range. If some means of coloring the air stream is used to permit distinguishing it from the vapors, it will be further found that the air flow will be relatively straight through from the inlet to the eductor.

In consequence, pockets of vapor will exist in parts of the tank remote from the eductor or from the open manways. Therefore, complete purging is slow and the possibility of a hazardous atmosphere existing over a relatively long period of time is almost certain.

This can be further illustrated by entering a tank equipped with a steam eductor at the top and an open manway in the bottom of the shell. It will be found that the stream of cool air entering the tank follows a definite channel from the point of ingress to the eductor and that, away from this channel, the atmosphere in the tank will be "muggy" and hot in comparison with the entering stream of fresh air. It also will be found that the only comfortable spots in such a tank are in a narrow channel between the inlet of the air stream to the eductors.

Further proof may be inferred from an actual experience with a tank fire at the Norco Refinery several years ago. Purging then was being effected by the use of an eductor mounted at a roof opening and a fresh air opening located in the bottom of the shell.

The fire started shortly after the eductor had been started. The use of fog nozzles not having been developed, ignition occurred from some other source; the exact cause was never ascertained.

As soon as the vapor flashed, a literal "tunnel of flame" was seen from the open manway directly to the eductor by what might be considered the shortest possible path. Observation through the air inlet clearly established this fact, but the fire showed no tendency to engulf the entire vapor area of the tank.

In desperation, the supervisor decided to continue using the eductor for fear that, otherwise, complete mixing of the tank contents might occur and be followed by a disastrous explosion. The fire appeared to have been doing no great harm although the "bore" of the "tunnel" gradually increased; so it was allowed to burn.

When the fire was observed to have nearly burned out, the eductor was shut off. Flame momentarily spread circumferentially around the tank and throughout the whole vapor area, then subsided principally to consuming "grease" on the walls.

Had there been complete mixing, evidence of rapid purging of the tank, it is believed unlikely that a "tunnel of flame" would have developed and simply grown larger with the passage of time.

Instead, there would have been an explosion. However, it is possible that the "flue effect" of the burning gases might have minimized turbulence and assisted in channelizing the flame path.

Regardless, when coupled with personal observations of men working in tanks under this method of ventilation, it is believed that the channelizing is a natural occurrence and thorough mixing of the tank vapor with incoming air is uncommon in all but very small tanks.

Fear of static electricity which might be generated by fog nozzles led at least one authority[5] to question their use. Norco personnel do not agree that this is hazardous because both the fog nozzles and the tank are separately- and well-grounded. In addition, the nozzle is supplied with water which, in itself, constitutes an additional ground and fog also impinges on the flange of the roof nozzle and thereby grounds to the tank.

The entering air is humidified nearly to the saturation point by passing through the curtain of fog, and remains quite humid even after it has been in the tank a considerable time. This is the observation of workmen entering the tank. Humid air is a poor candidate for perpetuating conditions which otherwise might lead to generating static electricity.

The only time it is believed static electricity might be generated despite the fog nozzle is during "snappy" fall and winter weather, when the air is very dry—or in dry, hot climates. This can be readily avoided by warming the water up to 100°F with steam, for instance. Reclaimed water from the tank also could be used.

Ignition by pyrophoric iron sulfide was pointed out in several comments, the consensus being that the Norco procedure might be hazardous since there is apparently no provision for keeping this material constantly wetted down while the tank atmosphere is in the explosive range.

Actually, any roof, shell and bottom deposits will be kept wet at all times when the Norco procedure is used. This was demonstrated clearly in an experiment which showed that fog would not only minimize development of an explosive atmosphere from simply diluting the hydrocarbon vapor, but moisture condenses on shell and roof. A newly-cleaned 55,000-bbl. tank was utilized for the purpose, which permitted observers to be present in the tank during simulated "purging."

The tank was prepared for purging with the Norco procedure. At several points under the roof, well away from the air inlets, cotton pads were installed to prove the efficacy of under-roof and shell wetting when fog nozzles were protecting the air inlets. Lights were installed to assist observations.

Fog was started; then eduction. Within less than two minutes a sharp increase in humidity was plainly evident to the observers standing on the bottom of the tank; shortly thereafter extensive wall sweating was observed. The cotton pads, not in physical contact with the roof but separated from it by perhaps an inch, were found "sopping wet" at the conclusion of the test. Rivulets of water were seen running down the walls, dripping from roof supports and trickling down support columns. However, roofs of black tanks are cooled externally by water spray just to make sure moisture does condense on the under-side during purging.

Within 15 minutes after purging commenced, the observers had to leave the tank because the air had become so humid breathing was very difficult.

Further proof of the pudding advanced by Norco personnel is not experimental. The plant often stores sour crude and has sour products in storage. Iron sulfide deposits are commonly found in these tanks. But never once since instituting the roof-mounted purging procedure has there been ignition or burning of these deposits.

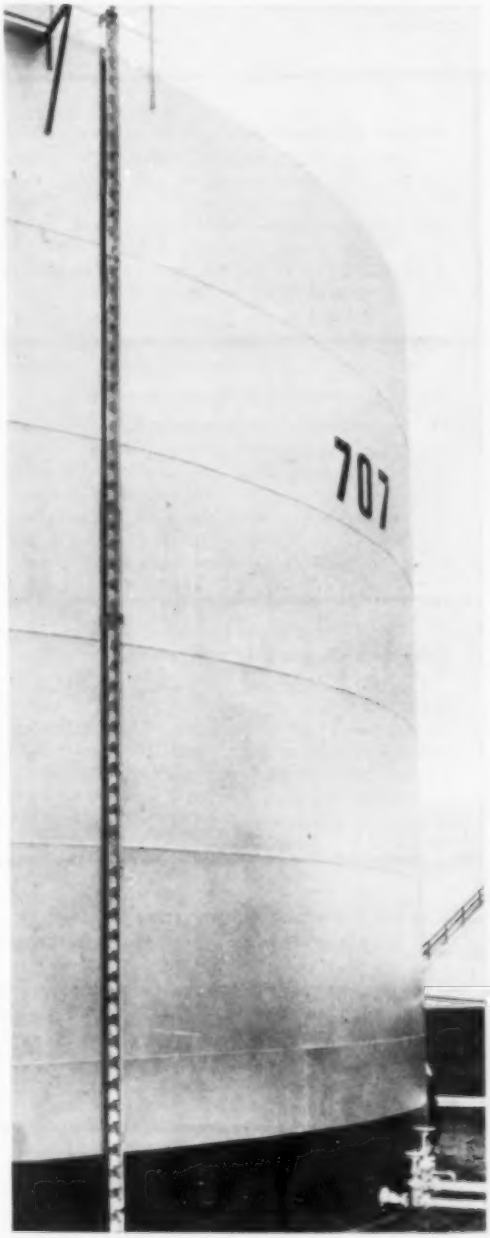
Acknowledgment

The cooperation of Shell Oil Co. in providing data for the preparation of this article is greatly appreciated. The author is particularly indebted also to H. A. LeBlanc, Engineering Dept., and V. E. Bradley, Safety & Fire Dept., both at the Norco Refinery, for arranging special tests and providing constructive criticism of the article.

References

(1) Anon. "How to Gas-Free Storage Tanks," PETROLEUM PROCESSING, Dec. '52, p. 1778.
(2) Black, R. W., "Safe Handling of Petroleum Products," American Petroleum Institute Annual Meeting, Chicago, Nov. 8, 1948, and private communications.
(3) Accident Prevention Manual No. 1-B. American Petroleum Institute, 2nd Edition, Oct. '50.
(4) Johnson, O. W., Standard Oil of California. "Memo on Tank Ventilation," private communication.
(5) Sluze, F. J., Ashland Oil & Refining Co., private communication.

Unusual Features at Mandan



FASTER TANK GAGING—All refinery tanks are gaged directly in barrels, instead of in the usual feet and inches. This practice eliminates the time-consuming use of conversion tables, and keeps the possibilities of gaging errors to a minimum.

NO SNOW TO SHOVEL and piping easily accessible—Standard Oil Co. (Indiana)'s new plant in Mandan, North Dakota, has roads, railroad tracks, and main process areas several feet above surrounding ground level, to lick the problem of natural snow drifts. Piping, except for buried water and sewer lines is above ground too, on low concrete pads about a foot off the ground, where it can be reached without scaffolds.

SAFER PUMPING—All yard transfer, rail and truck loading pumps in the open. Keeps initial costs to a minimum and eliminates the danger of explosive gas concentrations in enclosed pumphouses. Experience may dictate the need for a roof to keep off snow and ice.

TOPS in "What's New!"—1954

Here are brief repeats of the most interesting items reviewed in the monthly "What's New!" section during the year just ended. As a service to readers who might have missed them, may not have been receiving this magazine, or may now find them of value in their work, the editors have assembled these "Tops in What's New! —1954" on this and the following page.

A code number has been assigned to each item. You are invited to use the regular Reply Cards, which you'll find between pages 108 and 109, to request further information about equipment or copies of the helpful trade literature.

Plastic Piping

. . . now being made available as a new product by Republic Steel: a 12-page Catalog, *Number ADV 603*, tells why the company entered the plastic pipe field, the two principal types of plastic pipe being made, how to make joints; and engineering and corrosion data. Republic Steel Corp., 3100 East 45th St., Cleveland 27, Ohio.

Circle No. **1** *on Reply Card*

Ethylene Compounds

. . . scheduled for production at new plant in Orange, Texas, including oxides and glycols; 33 pages on uses, chemical and physical properties, handling, storage and safety information, reaction formulas, analytical procedures; charts, diagrams and graphs. Allied Chemical & Dye Corp., Nitrogen Div., 40 Rector St., New York 6, N. Y.

Circle No. **2** *on Reply Card*

Pump Fundamentals

. . . explained in a booklet covering the operating principles of a centrifugal pump; including definition of terms used in calculations and a section in which typical pump problems are worked out. Ingersoll Rand Co., Cameron Pump Dept., 11 Broadway, New York 4, N. Y.

Circle No. **3** *on Reply Card*

Stainless Steel in Refinery Service

. . . its performance, and complete data on corrosion resistance and high temperature properties in tables and charts; application information with drawings indicating use in six different petroleum processes: a 46-page booklet. United States Steel, Pittsburgh 30, Penna.

Circle No. **4** *on Reply Card*

Pressure Loss Calculator

. . . for steam valves: slide chart estimates pressure drop and indicates proper size steam valve needed for any pressures up to 1500 psi.; full operating instructions and necessary technical data are printed on the calculator. Golden-Anderson Valve Specialty Co., 1264 Ridge Ave., Pittsburgh 33, Penna.

Circle No. **5** *on Reply Card*

Synthetic Organic Chemicals

. . . and their physical properties are covered in the new 1954 edition of a 20-page, annual booklet; data on more than 330 products and 36 new chemicals, in easy-to-use tabular form; *PPSOC Booklet F-6136*. Carbide and Carbon Chemicals Co., 30 East 42 St., New York 17, N. Y.

Circle No. **6** *on Reply Card*

Stainless Steel in Chemical Processing

. . . is described in a 34-page booklet, explaining the value of the alloy in manufacture of different chemical products; including corrosion resistance data, fabricating information, and a selection guide. Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 19, Penna.

Circle No. **7** *on Reply Card*

Manual for Fractionator Trays

. . . for the installation of the manufacturer's "Truss-Type" bubble trays: *Bulletin No. 154* contains 26 pages of technical and engineering information, data, and help for the user. Fritz W. Glitsch & Sons, Inc., P. O. Box 6227, Dallas 2, Texas.

Circle No. **8** *on Reply Card*

Ammonia from Natural Gas

. . . processing plants; yield and cost data, principal operating features and the economics of a process design utilizing the high pressure of natural gas; eight-page booklet. M. W. Kellogg Co., 225 Broadway, New York 7, N. Y.

Circle No. **9** *on Reply Card*

Mono, Di, and Tri Ethanolamine

. . . their properties, chemical performance, and pH values; vapor-liquid composition curves; viscosities, total vapor pressures of solutions; booklet also contains list of properties of ethanolamine soaps. Dow Chemical Co., 45 Rockefeller Plaza, New York City.

Circle No. **10** *on Reply Card*

Liquid Feeder Has Built-In Ejector

. . . eliminating the need for a proportioning pump. The "Feedrator" is designed for simultaneously metering, controlling, mixing, and dispensing small quantities of liquid chemicals into liquid streams. A pressure differential in the main line, which creates a by-pass flow through the ejector, is all that is necessary to operate the unit. Unit is enclosed in a Lucite block, facilitating the feeding of many chemicals directly into the main process stream. For additives which Lucite cannot handle satisfactorily, the block is available in Uscolite at some additional cost. The unit comes in four standard models with capacities ranging from 0.03—0.3 to 2-20 gal./hr. A small ball check valve provides protection against sudden pressure drops. Fischer & Porter Co., 19 Jacksonville Rd., Hatboro, Penna.

Circle No. **11** *on Reply Card*

Graphite Material Stands High Temperatures

. . . up to 5700° F. and almost all types of corrosives. Trademarked "Graph-I-Tite" it is an impervious graphite and is being used in such equipment as heat exchangers, boots, nozzles, and so on. It holds up under high temperatures because the carbon itself fills the pores in the graphite, rather than the usual resins which would be subject to chemical attack or heat decomposition. In tests, the material has given good service at the boiling temperatures of all concentrations of such corrosives as formic, hydrochloric, monochloracetic, and oxalic acids; ammonium hydroxide, ferric chloride, nickel sulfate, acetone, benzene, carbon tetrachloride, ethylene dichloride, gasoline, isopropyl alcohol, and trichlorethylene. Falls Industries, Inc., Solon, Ohio.

Circle No. **12** *on Reply Card*

Catalyst Will Remove Hydrogen Sulfide

. . . from air or gas streams. The basis of the catalyst is activated carbon treated with various metal oxides such as vanadium, copper, iron and/or chromium. Hydrogen sulfide is oxidized to sulfur and water with 100% efficiency from gases or air in a wide range—up to 2% by volume—until the activated carbon has increased in weight by 25%. This increase is 10% water and 15% sulfur. Breakdown of the catalyst is reached when it starts passing 5 ppm. of the H_2S. Reactivation may be accomplished by steaming or dissolving the sulfur, then drying the catalyst with a current of air heated to about 125° C. Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.

Circle No. **13** *on Reply Card*

Steam Tracer Is Integral with Pipe

. . . solving a chemical plant problem in the transfer of sluggish materials or tricky solutions. It is a development by engineers of both Aluminum Co. of America and Hercules Powder Co. called "Unitrace." It consists essentially of an integrally extruded steam-traced aluminum pipe. Extruded from Alcoa 3S-F alloy, the product is slightly oval in cross section due to the crescent-shaped steam passage adjacent the main conduit. Pre-formed insulation will fit the Unitrace piping: for example; for 2-in. pipe, insulation for 2½-in. standard pipe will fit. At joints between sections of Unitrace, a jumper made of Utilitube carries steam across. Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Penna.

Circle No. **14** *on Reply Card*

Mass Flow Meter Uses Gyro Principle

. . . to measure quantity of rate of flow directly in terms of weight. In essence, the fluid to be measured passes through a circular pipe which corresponds to a rotating gyroscope wheel. The torque produced in this rotating circular assembly is in direct proportion to the mass flow. The measurement of this torque by means of a properly calibrated indicator gives the measurement of the mass of fluid flowing through the instrument. The device can be used for any fluid and will also work on systems containing a limited amount of solids. Accuracy is claimed to be 0.25% under the present design, with a possible accuracy of 0.10% anticipated with further development. Initial models will have a capacity of about 500 lb./min., with later designs going up to about 1000 lb./min. Control Engrg. Corp., 570 Providence Highway, Norwood, Mass.

Circle No. **15** *on Reply Card*

Orifice Design for Flows of Varying Viscosity

. . . changes over the range of Reynolds Numbers from 500 to 250,000. It has a quadrant plate with a rounded approach on the upstream face; the design being the result of European research for the measurement of flow rates of liquids with varying viscosities. The usual, sharp-edged orifice plate has predictable performance only for Reynolds Numbers of 15,000 to 50,000. The manufacturer states the quadrant orifice plate can also be used to measure small liquid flow rates. Taylor Instrument Companies, 95 Ames St., Rochester 1, N. Y.

Circle No. **16** *on Reply Card*

For news about current new products, equipment, processes, or literature please turn to the regular "What's New!" section in this issue, beginning on page 109.

How to Handle . . .

Field Welding of Pressure Vessels

By F. A. UPSON
Standard Oil Co. (Indiana)*

FIELD-WELDING of heavy-wall pressure vessels requires the solution of many problems. These result principally from the inconvenience of providing for adequate fit-up, welding from fixed position, rigging of scaffolding and other measures for inspection, adequate stress-relieving and weather protection measures.

There have been numerous jobs at the Whiting refinery of Standard Oil Co. (Indiana) that required field welding of vessels ranging from 8 to 60 ft. in diameter and 1 to 2 5/16 in. in thickness. There have been many instances of replacing shell plates, nozzle installation and flush inlaid patches in vessels from 4 to 15 ft. diameter by 2 to 5 in. thick. Plate materials were ASTM A-285 Grade C or equal, A-201 Grade A, and A-212 Grades A and B. Both grades of A-212 included thicknesses up to 2¾ in.

The problems encountered are reviewed here, along with the precautionary measures justified, and a description of remedial actions occasionally required.

These problems are not essentially different from those encountered in shop welding, but they stem from field conditions. For instance, the cost of field stress-relieving is always much higher than in the shop. Insulating the vessel is involved and elaborate facilities may be required to provide and distribute heat uniformly to the various parts.

Many of the procedural details and precautions which follow may, at first glance, seem excessively expensive or unnecessarily conservative. However, hard-earned experience testifies to their justification. Attempts to save time or expense by short-cuts are almost certain to result in the ultimate expenditure of far more than can possibly be saved; an inferior job probably will be produced as well.

The information is arranged into three major sections: 1) before welding is started—the preliminaries, 2) welding proper, and 3) post-welding operations—the wind-up. The first section includes design considerations, the choice of type of weld, fit-up, provisions of shelter, and pre-heating. Section two, on welding proper, includes procedure, choice of weld rod, etc. The last section discusses inspection and stress-relieving procedures.

Before You Start

Fit-Up and other Preliminaries

FULL-PENETRATION welds for attaching nozzles and other appurtenances should be used whenever feasible. Welds of less than 100% penetration or having unfused roots (such as reinforcing pad fillet welds) have been found extremely troublesome. Not only is difficulty encountered initially in obtaining a weld free of root cracks, but also during service from possible cracking or the propagation of cracks.

A nozzle of the integrally reinforced butt-welding type can be installed more satisfactorily (with a little care) than the conventional, integrally reinforced nozzle or the built-up nozzle assembly having a separate reinforcing pad. This construction also has the great advantage of being susceptible to easy radiographic examination. Experience with this construction is based upon successful experience in full-penetration field welding of a number of solid flush-inlaid patches in vessel shells up to five inches in wall thickness.

The objections to butt-welding type nozzles which frequently are raised may be largely a manifestation of superstition, based perhaps upon a lack of actual experience with such details. The successful field installation of solid inlaid patches indicates that butt-welding type nozzles are entirely practical and the ease with which they can be radiographed is of such major importance that this type of construction should be used whenever possible in the shop as well as in the field.

Fit-ups should be made with great care. There appears to be a tendency to use insufficient care, due to the difficulty in handling heavy plate in the field as compared to the shop. The importance increases with thickness, irrespective of where the work is done, but is even more important in the field because, among other things, all welding must be done with the vessel in a fixed position. Trial fit-up in the shop prior to shipment is very desirable.

Flame-cutting and gouging are OK for achieving good fit-up and often permit cost reduction. However, the work must be preheated in the affected area to minimize so-called "flame-cutting cracks" along the burned surface. All flame-cut or gouged surfaces should be "Magna-fluxed" prior to welding to assure that there are no cracks present.

Fit-up shifting should be prevented with suitable heavy fingerbars, strongbacks, braces and the like, at least until a very substantial amount of weld metal has been deposited. Accomplish the fit-up whenever possible so that jacks, wedges and similar expedients are not required to maintain the position of the plates, even though they may be needed to achieve the proper positions initially. Local heating with or without sledging should never be permitted in achieving the fit-up.

Provide a uniform root-gap in the welding groove during fit-up, if necessary by building up with welding rod and then chipping or grinding to desired dimension. Variations exceeding 1/16 in. from the nominal dimension are likely to cause trouble. The proper width of land at the center of a double-bevel is sometimes subject to argument but a nominal width of about 1/16 in., which seems to be a reasonably practical minimum, has much in its favor. Less than this may result in an uneven feather edge, while more will often increase the amount of back-chipping required.

These suggested limits are subject to considerable variation if a back-up bar is used, but this is hardly practicable unless flame or arc-gouging is to be used instead of chipping for preparing the back-groove.

A double-U type groove is desired if plate edges can be machined, to minimize weld metal especially in

* This article has been adapted from a paper, "Field Welding of Heavy-Wall Pressure Vessels," presented by Mr. Upson at the Petroleum Mechanical Engineering Conference, American Society of Mechanical Engineers, Los Angeles, Sept. 26-29, 1954. Salient points of the following floor discussion have been incorporated.

thicknesses of over 1½ in. Otherwise a double-V type groove should be provided. In either case the groove should be no wider than necessary to permit adequate access to the root; in no event should access be restricted.

A 60° included angle seems to be a sound compromise for a double-V groove between the two points of view calling for either 45° or 75°. The former is defintely too narrow while the latter is wider than necessary. An unsymmetrical bevel has the theoretical advantage of equalizing distortion resulting from weld shrinkage, but this advantage often is largely lost in practice because it is impossible to predict accurately how much back-chipping may be required.

All welding edges should be Magnafluxed after beveling to assure the absence of flakes, laminations and other discontinuities which might interfere with the production of sound welds. This is important because of the difficulty of making repairs after the parts to be joined have been erected in position. All plate surface defects should be repaired prior to erection.

Adequate weather protection for the work is another must. This includes facilities to keep wind, rain and snow away from the welding area as well as to protect the work (and the welders) from exposure to wind or low atmospheric temperatures. In some cases, tarpaulins can be hung while, in other cases, temporary plywood enclosures are needed.

Preheat should be applied after fit-up has been completed in a manner to avoid nonuniform expansion which would affect the fit-up adversely. This usually means that all edges of each sheet involved must be brought to essentially the same temperature even though welding on all edges at once rarely can be considered. The application of temporary insulation may be necessary, in which case pins or clips applied with a stud-welding gun are very useful.

Electric strip heaters are usually the most convenient and satisfactory method of providing preheat. In some cases, propane or fuel-gas burners can be used, provided they produce a clean, soft flame and are satisfactorily designed and located to avoid excessive localization of heat.

Acetylene torches are not satisfactory.

Where the only welding involved is on the outside of the vessel, and where the strength of the vessel is adequate, as might be the case of repairing an external nozzle weld in an existing vessel, the introduction of 100 psi. steam inside the vessel is an excellent preheating means.

Steam preheating is not always the cheapest method but it is advocated for ease of control. Considerations must be given its availability to the work site and in the required volume as compared with the availability of electric power and adequate circuitry. Welding machines can furnish power but it is necessary to insulate the vessel: commercial strip-heaters using AC power are much easier to handle.

Preheating should be maintained until a job is completed. When it is necessary to stop a job for a protracted period—say 30 days—the preheat should be brought slowly down to ambient temperatures. When work resumes, the preheat is brought up as on a new job. If work stoppage is only for two days or so, maintain preheat.

A preheat temperature of about 400° F is desirable for plates over 2-in. thick, particularly such high-tensile material as ASTM A-212, although a 300° F (minimum) often has been adequate. A 200° F preheat is very desirable but apparently not essential for such ordinary mild-steel material as ASTM A-285, Grade C, in thicknesses ranging from 1 to 2 in.

Never attempt primary strength welds on a thick vessel when the parent metal is at essentially less than normal "room temperature." Where a nozzle or patch is being installed, particular care should be exercised to be certain that it is not hotter than the surrounding shell.

The Job Itself

Procedures for Welding

ONE of the most important features of any sound field welding procedure is arranging the work so that, when welding has once commenced on any seam, it is continued without interruption until that seam has been completed.

If this is impossible, then arrangements should be made at least to permit maintenance of preheat without interruption until welding has been completed. In no case should welding be interrupted until a substantial portion of the total weld thickness has been laid down.

Cleaning the weld meticulously between each pass of metal prior to deposition of subsequent passes is extremely important. Interpass cleaning should include conscientious removal of every crack, undercut and pinhole as well as removal of all slag. In some respects this is more of a "dressing operation."

Chipping is preferred for cleaning over flame-gouging. An experienced operator with a sharp gouge is essential to avoid rolling the metal against the side wall of the groove or smearing metal over a pocket or undercut. Where a question exists as to the adequacy of the interpass cleaning, magnaflux is a valuable tool with which to make a definite check.

Heavy peening should be prohibited expressly in most cases because the benefit of minimizing cracking is at best questionable except, perhaps, under carefully controlled conditions. And these seldom exist in the field. It can result in the masking of pinholes, undercutting and slag. So-called "very light peening" for the purpose of slag removal only is considered acceptable but is seldom sufficient even for that purpose, it generally being necessary to follow up with a chipping tool in various spots.

The type of welding rod used will have a very great influence on the interpass cleaning operation. Slag from some types of rods is much more readily removed than that from others. A rod with a "digging" arc characteristic often will result in very troublesome undercutting (more so in some positions than others) at the edges of each bead. However, the extent to which this occurs is, in a measure, under the control of the individual welder. The important point is that undercutting might not be objectionable in other types of work, but it can cause considerable difficulty in the type of work under discussion.

Rod size depends on a number of different factors which vary from one job to another. Rarely should anything larger than ⅛-in. rod be used for passes near the root. Bead thickness will depend in part on the rod size but in each case the bead thickness should be moderate. If the bead is too thin, fusion may be impaired; if too thick, transverse cracking is invited. A reasonable rule of thumb in most cases might be: a maximum thickness equal to rod size but not exceeding 5/16 in.

A low-hydrogen type rod is distinctly worthwhile except that some of them, at least, apparently are unsatisfactory for work in the overhead position. To avoid excessive porosity when using them it is necessary to exercise very close control over the welders

(and machine settings) to make certain the operators are extremely careful in the manner in which they hold the arc and manipulate the rod.

Stringer passes are the rule irrespective of position. A cellulosic type of electrode (e.g., E-6010) should be employed to seal the root of the weld initially, so that the base of the arc will not be exposed in using the low-hydrogen rod.

"Backstepping" should not be attempted unless there is satisfactory assurance that the net overall effect will be beneficial. The advantages of a "backstepping" sequence in welding has occasionally been overstated or at least misunderstood, it is believed. Other things being equal, of course, backstepping will minimize weld shrinkage and cracking. Unfortunately it often is difficult to hold the "other things" equal.

If successive steps are to be adequately "tied in" to each other, for instance, or as is often the case, are to appreciably overlap, adequate interpass cleaning at the "tie-ins" or the overlaps may become almost impossible. A sharp undercut thus covered over presents an excellent opportunity for subsequent cracking and, in any event, probably will hold a slag stringer. From this point of view, certain types and brands of electrodes are much better suited than others to a backstepping welding sequence.

Welding need not be completed on one side of a double-bevel before preparing the groove on the other side for backwelding. After the first side has been from a third to half-filled, backchipping, flame-gouging or arc-gouging may be commenced for removing the back-up bar (if used) and all unsound root material.

After this has been completed and magnafluxing has demonstrated complete removal of any back-up bar and all cracked and otherwise unsound material, welding may progress on both sides of the joint simultaneously if desired.

Back-groove preparation by arc-gouging usually is the first choice if a skillful operator is available. It is even faster than flame-gouging and has much less tendency to propagate cracks. Recourse to chipping is recommended if a skillful arc-gouge operator is unavailable and the degree of constraint is high; flame-gouging where excessive constraint is not a problem.

A clean, arc-gouged surface is satisfactory for welding without further preparation but all debris must be carefully removed. The debris is exceedingly high in carbon content and may cause hard spots if puddled into a weld. The back-groove should be magnafluxed before back-welding is started, regardless of how prepared.

Butt-welded patches, full-thickness (flush type) are one of the most notoriously difficult weldments to complete successfully in heavy-wall pressure vessels. Variations from conventional practice in sequencing operations has been found very worthwhile in achieving routine success in installing 50 in vessel walls of nominal thickness ranging from 3 to 5 in. The sequence of operations is as follows:

1—Following careful fit-up and working from the outside without preheat, deposit from one to three stringer passes in the root with a cellulosic rod. Any cracks in this part of the weld are of no consequence.

2—Apply and maintain 300°F preheat (minimum) using gas rings mounted outside the vessel.

3—Complete the inside weld without root preparation, using a low-hydrogen rod.

4—Close the vessel and admit steam, gradually increasing flow while controlling the gas rings downward to prevent any sudden change in preheat. When the preheat is being maintained by steam alone, dismantle the rings.

5—Backchip or backgouge from the outside to remove the original root weld made with cellulosic rod as well as any underlying unsoundness. Magnaflux the prepared groove.

6—Complete the weld from the outside using a low-hydrogen rod.

7—Gradually reduce the preheat temperature to ambient by controlling the steam.

Two general precautions should be emphasized in following this procedure: Once welding under preheat (Step 3) has commenced, preheat should be maintained until all welding is complete (i.e., through Step 6). Step 3, once started, should continue without interruption to completion.

Step 4 is unnecessary if electric strip heaters are used instead of gas rings and Steps 5 and 6 may proceed before Step 3 is complete if so desired. The simplicity of a gas ring is advantageous for a circular patch and the reliability and uniformity of steam preheat for the outside half of the weld are unsurpassed.

The choice between one as compared to three stringer passes in Step 1 is not clear-cut. The total depth of backchipping or backgouging in Step 5 probably will be about the same in either case. If three passes are used, slightly more weld metal may be sacrificed, but if only one pass is used, the total depth of the outside groove is likely to be somewhat increased with attendant reduction in accessibility of the root.

There is a question of safety in backchipping a weld on a vessel under 100 psi. steam pressure but this is dictated by vessel strength. If the 100 psi. is a substantial portion of the allowable pressure under preheat conditions, safety considerations dictate other means for preheating.

After You're Finished

Inspection and Stress-Relieving

RADIOGRAPHIC inspection involves a choice between X-ray or gamma ray methods. It may pose a rather formidable problem with heavy-wall vessels and must be carefully considered before the job is commenced.

X-ray requires adequate means for manipulating the machine and may involve the use of rather extensive rigging.

Gamma-ray inspection will generally require much longer exposure times. It is the only choice when working with weld thicknesses of about 3 in. and greater because the size and weight of such high-voltage X-ray machines make them virtually inadmissible for the usual field job.

Inspection should closely follow welding so that unsatisfactory welders can be taken off the job before they have laid down more than a minimum of defective weld. Also, immediate inspection permits early modification of field-welding procedure if this should be found necessary.

When any vessel is shop-fabricated, the welders usually are men who have been in the fabricator's employ on a more or less regular basis and their capabilities are well known.

On the other hand, field fabrication often involves the employment of craftsmen recruited locally, with the result that considerably less will be known about them. While it is true that all vessel welders are customarily required to pass at least the standard AWS "operator's qualification tests," or equivalent, it is a well-known fact that many welders capable of passing such tests nevertheless seem unable to produce X-ray quality work with reasonable consistency.

Excavating for a weld defect revealed by radiography is best accom-

plished by chipping, flame-gouging or arc-gouging. Flame gouging is 10 to 20 times faster than chipping, even though preheating should be employed. Arc-gouging is even faster and preheating seems unnecessary. Always magnaflux the final excavation (after any necessary dressing) before rewelding.

Reradiographing the excavation before rewelding is often worthwhile to assure that the defect has been removed. The check film should be shot from a different angle than the original so that, if the defect remains, it can be more precisely located by triangulation.

Defects should be virtually nil when proper procedures are used and due care exercised before and during the original weld. No more than 1% of the original films should exhibit any objectionable defect, as compared to as much as 10% or more on many manually-welded shop jobs. The total length of objectionable defects on several field jobs has been found well under 0.1% of the total seam length.

Full thermal stress-relief of an entire heavy-wall vessel is best accomplished in the field with a gas-fired furnace which may or may not be equipped for recirculation of flue gas. Catalytic cracking vessels can be stress-relieved with the air preheater.

The greatest difficulty in obtaining satisfactory stress-relief usually results from the lack of adequate provisions for even distribution of heat throughout the vessel. Merely inserting a burner inside the vessel itself is most unsatisfactory. The burners should be located in an external furnace, from which the hot flue gases are piped to the vessel.

A very simple portable heater can be bolted to the bottom or side manway of the vessel to be stress-relieved. Thermocouples are inserted in the flue gas stream in addition to those located in the vessel. The flue gas temperature at the vessel inlet usually is kept below 1800°F and a large amount of excess air is admitted to assure adequate flow of gas for uniform heating.

Air to the burners must be premixed with flue gas to produce a clean flame. Provision must be made to admit a large amount of excess air to control flue gas temperatures to a reasonable level. Otherwise, adequate control of vessel temperatures will be impossible, even if the internal baffling is not functionally destroyed due to warpage. The greater the flow of flue gas through the vessel, the greater the turbulence and the more even will be vessel temperatures.

Recirculation of flue gas is very attractive in theory. In practice, however, it often seems to be more trouble than it is worth. The extra equipment required may be difficult to provide and entails considerable work to install. Furthermore, the extra complication presents many additional opportunities for things to go wrong. Unless the case for recirculation is so strong as to be undeniable, it probably is better not to attempt it.

Adjustable dampers and aspirators should be provided in stacks or vents located generally on each manway and major nozzle. Unequipped nozzles should be blinded. Baffling (distributor ducts and dampers if necessary) should be provided in appropriate design to insure even distribution of hot flue gas.

Heavy insulation should be applied to the outside of the vessel with particular attention to nozzles, manways, flanges, reinforcing pads, points of support and miscellaneous attachments. About 4 in. of blanket insulation ordinarily will be the minimum acceptable. Wind must be prevented from blowing across the blankets, but be certain no combustible materials, such as tarpaulins or wood, can approach the heated parts.

Additional insulation in liberal supply (and craftsmen to apply it) must be readily available should more be required at any point after stress-relieving has commenced. It is of paramount importance that insulation be securely installed initially; very serious consequences may result if even part of the insulation should fall off when the vessel is at or near stress-relieving temperature. It is virtually impossible to reapply insulation to a surface at 1100°F and a large amount of time is lost in repeating the stress-relieving operation even if the vessel sustains no damage.

Use welded type thermocouples, tack-welded to the vessel. Penned thermocouples often are unreliable. Temperatures should be measured in the furnace; flue gas at vessel inlet and representative outlets; and at representative points inside the vessel remote from the inlet.

Each thermocouple should be connected to a recorder. Two 12-point recorders usually are sufficient. Leads should be arranged so that each one records points well-distributed over the vessel. An instrument man should be readily available if a quick repair becomes necessary.

Fairly complete temperature coverage of the vessel is necessary. No detailed rules for the number required or locations can be given. In general, however, it has been found that a thermocouple usually should be located on the reinforcing pad and the neck of each manway and major nozzle; similarly for representative minor nozzles.

Each vessel head should be equipped with thermocouples dependent in number on vessel diameter, orientation, and head-nozzle locations. They should be provided at every 8 to 10 ft. of shell length; on vertical vessels, one at each end of a diameter in each such space; on horizontal vessels, top, bottom and each side should be so equipped. The geometry of the individual vessel and appurtenances, means of support and nature of internal flue gas baffles must be studied carefully in deciding where exactly to locate the thermocouples.

Cooling the insulated vessel at a reasonable rate after the required time at stress-relieving temperature must be arranged by injecting cool air under strict control to assure uniform heat reduction. If no cooling means are provided, experience indicates a heavily insulated vessel will cool down at a rate not over 5 to 10°F per hour.

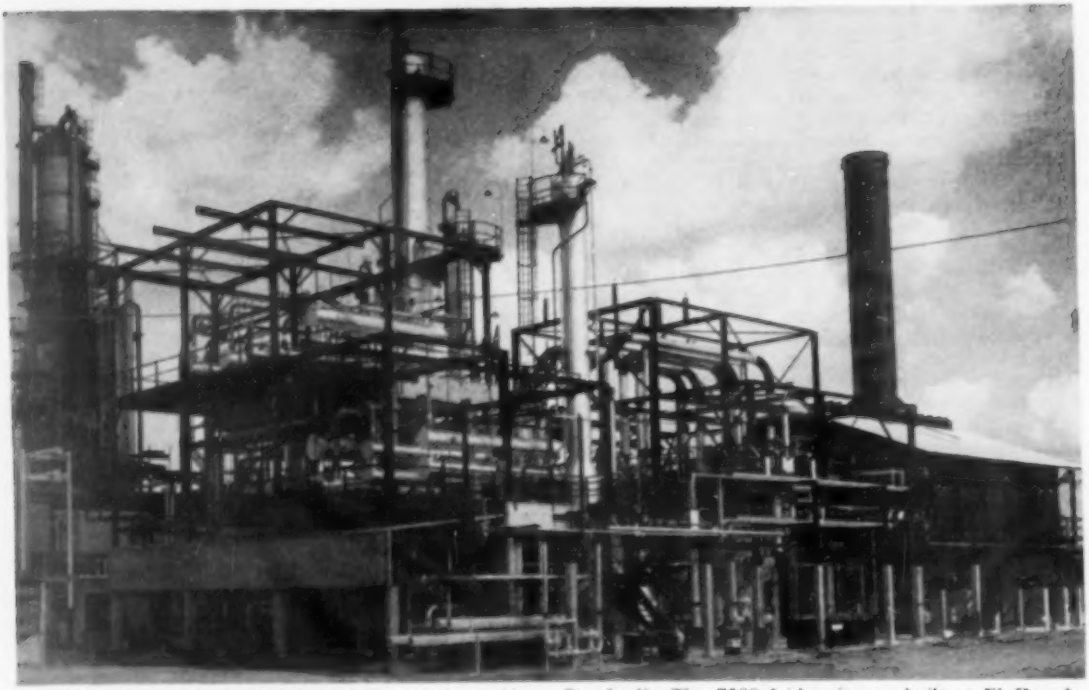
Vigilant, detailed, competent attention to operational progress must be maintained uninterrupted, around the clock, until stress-relieving is completed. The importance cannot be overemphasized, since fluctuations in fuel-gas pressure, air-line pressure, wind direction and velocity all have a critical effect on stress-relieving, while the response of metal temperatures to these fluctuations—and corrective action—usually is sluggish.

Each different size and shape of vessel is something of an independent problem; experience gained on one vessel will not be directly applicable to another, different vessel in all details. However, it is perfectly feasible to raise vessel temperatures uniformly at 40 to 50° per hour to temperatures even in excess of 1200°F. Uniform cooling rates as high as 50 or even 75° per hour also can be obtained.

The total spread of temperatures on heating or cooling over the entire vertical vessel can be kept within 100°F without excessive difficulty. The spread at stress-relieving temperature ordinarily need not exceed 40 to 50°F. The total spread in the case of horizontal vessels will be about double that for vertical vessels.

Magnaflux at least all manway, nozzle, reinforcing pad and patch-plate welds after stress-relieving is completed and before a hydrostatic test.

A field stress-relief job actually superior to a great many full-furnace shop stress-relief treatments can be obtained with careful planning and by intensive following of each detail in the actual operation.



HIGH SPEED CONSTRUCTION—147 actual working days and 46 days ahead of schedule—that's the record on this first commercial scale Ultraformer (fixed bed catalytic reforming process developed and licensed by Indiana Standard). The 7300 b/d unit was built at El Dorado, Ark., for Pan-Am Southern Corp. by Lummus Co. Ground-breaking was Oct. 24, 1953 and the job finished May 7, 1954.

FIRST NEW ENGLAND-MADE LPG will come from this 1000 b/d unit just completed at Esso Standard Oil Co.'s Everett, Mass., refinery. It is one of three new units in the plant modernization program at Everett. Others include a 13,500 b/d asphalt vacuum pipe still and a liquid hydrocarbon purification plant.

SCIENCE–CANARY TEAM helps assure safety at the Esso Laboratories in Baton Rouge, La. Researcher Bill Metrailer stands by the new combustible gas detector while feeding the other partner in what the laboratories have found to be a very effective safety team. Actually, the instrument can cover far more territory than the bird.

Next time try . . .

'Step-Wise' Heat Transfer Calculations

. . . when accuracy is a "must"

Competition among heat exchange equipment suppliers and users requires accurate design methods. Published for the first time, the following "Step-Wise" heat transfer calculation method allows accurate solutions for difficult problems.

By EDWARD R. GRAHL
Chemical Engineer
Wilmington, Delaware

UNDER-DESIGN" of a single piece of heat transfer equipment can prevent an entire process plant from operating at capacity. Conversely, "over-design" involves unnecessary expense for the user, or lost sales for an equipment supplier during competitive bidding.

Since it is always desirable to prevent "under-" or "over-design" of heat transfer equipment, it is necessary to approach design calculations with an economically feasible philosophy. Expenditures for design should not be excessive in relation to the cost of the equipment under consideration.

For instance, the fabrication cost of a 400-sq. ft., stainless steel, shell-and-tube heat exchanger can be estimated at roughly $6000 (400 sq. ft. times about $15 per sq. ft. of heat transfer area). Accurate design for this equipment might require two man-days. Assuming technical time worth $10 per hour—including salary and administrative overhead—design cost for this exchanger would be $160, or about 2.7% of the final fabricated equipment cost. Considering the consequences of a poorly operating process plant, or a lost sale, the extra cost for an accurate design can be justified.

During the investigation of different design methods by the author, the primary consideration involved the presentation of an accurate method for special cases of heat transfer which would not require an excessive calculation time.

The design methods for two-fluid heat transfer occurring without phase change in shell-and-tube equipment as set forth in Kern[2] and TEMA[4] generally require about one-half day in experienced hands. However, they incorporate standard approximations based on fluid stream terminal conditions, and can be subject to serious error if the physical and/or thermal properties of either stream vary significantly during heat exchange.

Accuracy is increased by using Colburn's[3] "caloric temperatures" in conjunction with the above methods. The most precise and accurate heat exchange calculations are obtained, however, by combination numerical and differential solutions of the basic heat transfer equations over differential lengths of heat transfer area, but require too great an expenditure of time for all except special cases.

None of the above methods, nor any of the others investigated, will produce the desired accuracy with a nominal expenditure of time. The "step-wise" calculations, based on the principle of dividing the heat transfer process into equal temperature increments, is accurate and reasonably rapid. By this method, the effect of incremental variations of physical and/or thermal properties are included when calculating heat transfer areas and pressure drops. In cases where extreme changes in fluid viscosity occur during heat exchange, methods based on fluid stream terminal conditions and properties alone will be in error as much as 20 to 30% compared to "step-wise" results.

When to Use the "Step-Wise" Method

In general, if the fabricated cost of an exchanger will exceed $12 to $15 per sq. ft. of heat transfer area, the "step-wise" method should be used. Also, if the viscosity

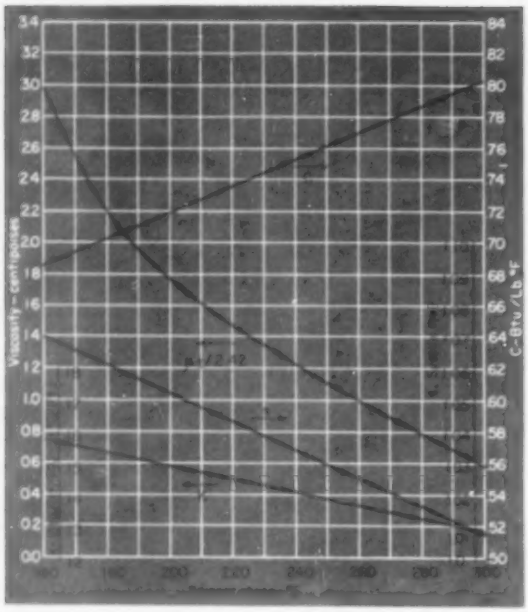


FIG. 1—Physical and thermal properties of 90 wt.% Ethylene Glycol

of one of the exchanging fluids shows approximately a three-fold or greater change, a "step-wise" procedure usually can be justified. When other physical and/or thermal properties change greatly during the exchange of heat over wide temperature ranges, the discretion and experience of the engineer must be exercised. The author has encountered the case where, in the design of a reactor-exchanger, the heat of reaction varied so greatly from end to end that a "step-wise" calculation was clearly indicated. "Step-wise" calculations can be used advantageously for heat transfer involving mixed phase flow such as condensation and vaporization.

Example of the "Step-Wise" Method

To simplify the presentation of the "step-wise" method, equations and methods will be discussed in relation to the following typical liquid-liquid heat exchange problem.

> Consider a shell-and-tube heat exchanger to be designed to cool 30,000 lb./hr. of 90 wt.% ethylene glycol solution from 300° to 160° F. Assume 86° F. treated cooling water is available, and select a 24° F. temperature rise.* Assume a one-shell two-tube pass exchanger with channel, tube sheets and tubes of type 316 stainless steel, and the shell of carbon steel. Select ¾ in. OD tubes, 16 BWG, 16 ft. 0 in. long, on a 1-in. triangular pitch. Because of the corrosive nature of traces of impurities in the glycol solution, it will be passed through the tube-side of the exchanger. The combined fouling factor will be 0.003.

The physical and thermal properties of 90 wt.% ethylene glycol solution have been plotted in Figs. 1 and 2 from data available in the trade literature.[9] An analysis of the viscosity curve shows a 5.5-fold increase in glycol viscosity from 300° to 160° F. Both criteria (fabricated material cost in excess of $12 to $15 per sq. ft., and a greater than three-fold viscosity change) exist in this case, so the "step-wise" method is indicated.

* Optimum cooling water temperature rises can be calculated (Kern[2]), but are usually in the range of 15° to 25° F.

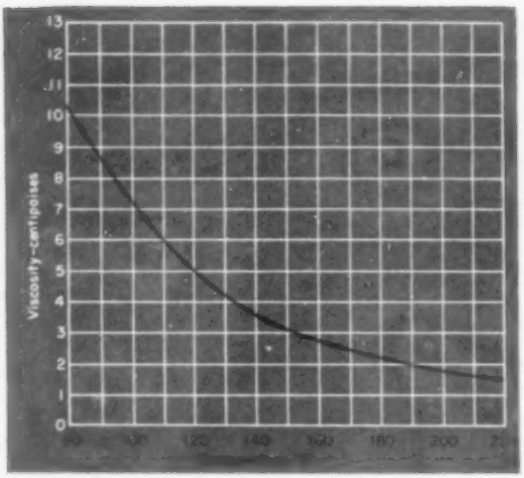


FIG. 2—Viscosity of 90 wt.% Ethylene Glycol

Calculation of Heat Transfer Area

The first calculation is to determine the exchanger heat duty requirements. Then the cooling water demand is determined, followed by the first approximation of the shell size and the number of tubes required. Please refer to table of nomenclature.

1. Exchanger Heat Duty Requirement, Tube-Side Glycol:

$$Q = WC(T_1 - T_2) = 30{,}000(0.75)(300 - 160) = 3{,}150{,}000 \text{ Btu/hr.}$$

2. Cooling Water Requirement, Shell-Side:

$$w = \frac{Q}{(t_2 - t_1)c} = \frac{3{,}150{,}000}{(110 - 86)(1.0)} = 130{,}500 \text{ lb./hr.}$$

3. Calculation of Exchanger Temperature Difference, Δt:

Hot Fluid	Cold Fluid	Difference
300	110	190
160	86	74
140	24	116

$$LMTD = \frac{(T_1 - t_2) - (T_2 - t_1)}{ln\dfrac{(T_1 - t_2)}{(T_2 - t_1)}} = \frac{190 - 74}{ln(190/74)} = 123° \text{ F.}$$

$R = (T_1 - T_2)/(t_2 - t_1) = 140/24 = 5.83$
$S = (t_2 - t_1)/(T_1 - t_1) = 24/214 = 0.112$
F_T = function of R and $S = 0.965$ (Kern[2] p 828)

This value of F_T is satisfactory: therefore a one-shell, two- or more-tube pass exchanger may be used.

$\Delta t = LMTD(F_T) = 123(0.965) = 118.7°$ F.

4. Heat Transfer Area, First Approximation:

$A = Q/U_D\Delta t = 3{,}150{,}000/(65)(118.7) = 408$ ft²

where:

U_D = Value selected on basis of experience or previous calculation = 65

5. Number of Exchanger Tubes, First Approximation:

$$N_t = A/La'' = 408/(16)(0.1963) = 130$$

where:

a'' = 0.1963 ft² outside tube surface/linear foot tube length for ¾-in. *OD* tubing.

6. Shell Internal Diameter: From a tube count table (Kern[12] p 842) select the shell diameter approaching N_t from Step 5. It will be noted that two tube-passes give 138 tubes, while four tube-passes give 122 tubes for a 15.25-in. *ID* shell. The four tube-pass figure will be used here, but if in the final determination of incremental heat transfer areas, the 122 tubes do not furnish adequate area, the calculations will have to be repeated using a greater number of tubes.

7. Check Step 6: The number of tubes selected in Step 6 being less than for Step 5, a corrected U_D must be checked against the value assumed in Step 4.

$$A = N_t La'' = 122(16)(0.1963) = 383 \text{ ft}^2 \text{ for 122 tubes}$$

$$U_D \text{ (corrected)} = \frac{Q}{A\Delta t} = \frac{3{,}150{,}000}{(383)(118.7)} = 69.2$$

U_D (*corrected*) agrees closely with U_D from Step 4; therefore, it is permissible to continue to Step 8.

8. Tube-Side Dimensions and Flows:

$$a_t = \frac{N_t a'}{144n} = \frac{122(0.302)}{144(4)} = 0.0639 \text{ ft}^2 \text{ total flow area}$$

where:

a' = 0.302 in² flow area per tube

$$G_t \text{ (Glycol mass velocity)} = \frac{W}{a_t} = \frac{30{,}000}{0.0639} = 469{,}000 \text{ lb./(hr)(ft}^2\text{)}$$

Table of Nomenclature

A = Total heat-transfer surface, sq. ft.
B = Shell baffle spacing, in.
C = Specific heat of hot fluid, Btu/(lb)(°F)
C' = Clearance between tubes, in.
D_e = Shell-side equivalent diameter = (4)(free area)/(wetted perimeter); ft.
D_o = Outside diameter of tube, ft.
D = Inside diameter of tubes, ft.
D_s = Inside diameter of shell, ft.
F_T = Temperature difference correction factor (Kern[12] pp 828-833)
G = Mass velocity of fluid, lb./(hr) (ft²)
ID = Inside diameter of tube, in.
ID_s = Inside diameter of shell, in.
L = Tube length, ft.
Ln = Total equivalent tube length for pressure drop calculations, ft.
$LMTD$ = Log mean temperature difference, °F
$N+1$ = Number of crosses for pressure drop calculations, dimensionless
N_t = Total number of heat exchanger tubes
OD = Outside diameter of tube, in.
P_T = Tube pitch, in.
Q = Total exchanger heat flow, Btu/hr.
$R = (T_1 - T_2)/(t_2 - t_1)$
R_d = Combined dirt and fouling factor, (hr)(ft²)(°F)/Btu
R_e = Reynolds Number, dimensionless
$S = (t_2 - t_1)/(T_1 - t_1)$
T_a = Average temperature of hot fluid at any given point, °F
T_{av} = Arithmetic temperature average for hot fluid terminal conditions, °F
T_1, T_2 = Inlet and outlet temperatures of hot fluid, °F
U_C, U_D = Clean and design overall coefficients of heat transfer, Btu/(hr)(ft²)(°F)
V = Fluid velocity, ft/sec.
W = Weight flow of hot fluid, lb./hr.
a'' = External tube surface area per linear foot of length, sq. ft./ft.
a = Cross-sectional fluid flow area, sq. ft.
a' = Cross-sectional fluid flow area per tube, sq. in./tube
c = Specific heat of cold fluid, Btu/(lb)(°F)
f = Friction factor, a function of Re, sq. ft./sq. in.
g = Acceleration of gravity, ft./(sec)(sec)
h_{io} = Heat transfer coefficient for tube inside fluid referred to tube outside diameter, Btu/(hr)(ft²)(°F)
h_o = Heat transfer coefficient for tube outside fluid, Btu/(hr)(ft²)(°F)
j_H = Factor for heat transfer (Kern[12] pp 834 and 838), dimensionless
k = Thermal conductivity of fluids, Btu/(hr)(ft²)(°F/ft)
ln = Natural, base e, logarithms
n = Number of exchanger tube passes
q = Incremental exchanger heat flow for "step-wise" calculations, Btu/hr.
s = Specific gravity of fluids
t_a = Average temperature of cold fluid corresponding to T_a, °F
t_{av} = Arithmetic average temperature for cold fluid terminal conditions, °F
t_w = Tube wall temperature, °F
t_1, t_2 = Inlet and outlet temperatures of cold fluid, °F
w = Weight flow of cold fluid, lb./hr.
$\Delta A'$ = Incremental heat transfer surface for "step-wise" calculations, sq. ft.
ΔLn = Incremental equivalent tube length for pressure drop calculations, ft.
ΔP_r = Tube-side return pressure drop, psi
ΔP_s = Total shell-side pressure drop, psi
ΔP_T = Total tube-side pressure drop, $\Delta P_t + \Delta P_r$, psi
ΔP_t = Total pressure drop through exchanger tubes only, psi
ΔT_t = Tube-side temperature increment selected for "step-wise" calculations, °F
Δt = True temperature difference in $Q = U_D A \Delta t$, °F
Δt_s = Shell-side temperature increment corresponding to ΔT_t, °F
Δt_m = Arithmetic exchanger mean temperature, not corrected by F_T
ϕ = Viscosity ratio correction factor, dimensionless
μ = Viscosity at average fluid temperature, lb./(ft)(hr)
μ_w = Viscosity at tube wall, lb./(ft)(hr)
ρ = Fluid density, lb./cu. ft.
Σ = Symbolizing the summation of incremental parts to give the total value

Subscripts (except as noted above)
s = Shell-side dimensions or properties
t = Tube-side dimensions or properties

Table 1—"Step-Wise" Calculation of Tube-Side Heat Transfer Coefficients (Not Corrected for Viscosity)

Glycol Temp. T_a	Viscosity cP	μ_t	C	k_t	s	Velocity $V_t=2.09/s$ ft./sec.	$Re_t = DG_t/\mu_t$	j_{HI}	$\frac{C\mu_t}{k_t}$	$\left(\frac{C\mu_t}{k_t}\right)^{1/3}$	$\frac{k_t}{D}$	h_i/ϕ_t	$\frac{D}{D_o}$	h_{io}/ϕ_t
(1)	(2)	(3)	(4)	(4)	(4)	(5)	(6)	(7)	(6)	(6)	(6)	(6)*	(5)	(6)
300	0.61	1.48	0.806	0.130	1.008	2.07	16,400	58.0	9.17	2.09	2.52	306	0.827	253
280	0.81	1.96	0.789	0.133	1.017	2.05	12,750	44.0	11.62	2.27	2.57	257	0.827	212.5
260	1.03	2.49	0.773	0.138	1.027	2.04	9,750	35.0	13.94	2.41	2.67	225	0.827	186.1
240	1.26	3.05	0.756	0.142	1.035	2.02	7,950	28.0	16.23	2.53	2.75	195	0.827	161.2
220	1.52	3.68	0.740	0.146	1.045	2.00	6,590	23.0	18.68	2.66	2.82	172.5	0.827	142.7
200	1.81	4.38	0.723	0.151	1.054	1.98	5,530	18.5	21.00	2.76	2.92	149.1	0.827	123.4
180	2.24	5.42	0.706	0.155	1.063	1.96	4,470	13.8	24.7	2.92	3.00	121.0	0.827	100.1
160	3.06	7.41	0.690	0.159	1.072	1.95	3,270	8.2	32.2	3.18	3.08	80.4	0.827	66.5

Notes: (1) From Step 9; (2) From Fig. 2; (3) $\mu_t = 2.42CP$; (4) From Fig. 1; (5) From Step 8; (6) From Step 10; (7) From Step 10 and Kern[2] p 834

Tubes per pass $= N_t/n = 122/4 =$ approx. 31

$$V_t \text{ (Glycol linear velocity)} = \frac{G_t}{3600\rho_t} = \frac{469{,}000}{3600(62.5)s} = \frac{2.09}{s} \text{ ft./sec.}$$

Tube $ID = 0.62$ in.
Tube $OD = 0.75$ in.
Tube $D = ID/12 = 0.62/12 = 0.017$ ft.
$L/D = 16/0.0517 = 310$
Ratio of tube diameters $= ID/OD = 0.62/0.75 = 0.827 = D/D_o$

9. Following the above initial determinations, the use of "step-wise" temperature increments begins. For this example, the glycol temperature range (300° to 160° F.) is divided into equal temperature increments of $\Delta T_t = 20°$ F. each. If greater accuracy is desired, smaller equally-sized temperature increments may be used. Using these increments, the heat transfer coefficients for the inside and outside surfaces of the exchanger tubes are calculated.

10. Tube Inside Surface Film Heat Transfer Coefficients:

$$h_i/\phi_t = j_{HI}\left(\frac{k_t}{D}\right)\left(\frac{C\mu_t}{k_t}\right)^{1/3} \text{ (inside coefficient)}$$

$h_{io}/\phi_t = (h_i/\phi_t)(D/D_o) = 0.827(h_i/\phi_t)$ the inside coefficient referred to the tube outside dimensions

where:
j_{HI} = function of L/D and Re_t (Kern[2] p 834)
$Re_t = DG_t/\mu_t$

See Table 1 for the calculation and tabulation of h_{io}/ϕ_t values.

11. Tube Outside Surface Film Heat Transfer Coefficient: Since cooling water changes are small over the temperature range being considered, average conditions and properties are used except when the "step-wise" values are specifically required to determine related tube-side values.

$$h_o/\phi_s = j_{HS}\left(\frac{k_s}{D_e}\right)\left(\frac{c\mu_s}{k_s}\right)^{1/3} = 89\left(\frac{0.36}{0.0608}\right)\left(\frac{1.0 \times 1.813}{0.36}\right)^{1/3}$$

$h_o/\phi_s = 904$ Btu/(hr)(ft²)(° F)

where:
D_e = equivalent diameter $= 0.73/12 = 0.0608$ ft.

$$a_s = \frac{ID_sC'B}{144P_t} = \frac{(15.25)(0.25)(7)}{(144)(1.0)} = 0.1852 \text{ ft}^2 \text{ flow area}$$

$G_s = w/a_s = 130{,}500/0.1852 = 705{,}000$ lb./(hr)(ft²) mass velocity
$\mu_s = 0.75(2.42) = 1.813$ lb./(ft)(hr) at $t_{as} = 98°$ F.
$Re_s = D_eG_s/\mu_s = 0.0608(705{,}000)/1.813 = 23{,}620$

Table 2 — "Step-Wise" Calculation of Incremental Cooling Water Temperatures

Glycol Temp. T_a	Glycol Temp. Interval	Glycol Increment ΔT_t	Glycol Average C	Glycol Mass Flow W	Incremental Heat Duty $q = WC\Delta T_t$	Water Increment $\Delta t_t = 4.6C$	Water Temp. Interval	Water Temp. t_a
(1)	(1)	(1)			(2)	(2)		
300								110.0
	300-280	20	0.798	30,000	480,000	3.68	110.0-106.3	
280								106.3
	280-260	20	0.781	30,000	469,000	3.60	106.3-102.7	
260								102.7
	260-240	20	0.764	30,000	459,000	3.52	102.7- 99.2	
240								99.2
	240-220	20	0.748	30,000	449,000	3.44	99.2- 95.8	
220								95.8
	220-200	20	0.731	30,000	439,000	3.36	95.8- 92.4	
200								92.4
	200-180	20	0.714	30,000	428,000	3.28	92.4- 89.1	
180								89.1
	180-160	20	0.698	30,000	419,000	3.21	89.1- 86.0	
160								86.0
					$Q = \Sigma q = 3{,}144{,}000$			

Notes: (1) From Step 9; (2) From Step 12

j_{is} = function of Re_s (Kern[12] p 838) = 89
$t_{as} = (t_1 + t_2)/2 = (110 + 86)/2 = 98°$ F.
$k_s = 0.36$ Btu/(hr)(ft²)(° F/ft) at $t_{as} = 98°$ F.
$c = 1.0$ Btu/(lb)(° F) at $t_{as} = 98°$ F.

12. Calculation of Incremental Cooling Water Temperatures Corresponding to Assumed Glycol Temperature Increments: An incremental heat balance, as shown below, allows the calculation of the cooling water temperatures corresponding to the glycol temperature increments selected in Step 9.

$$q = wc\Delta t_i = WC\Delta T_i$$

where:

$$\Sigma q = Q$$

Rearrangement and solution for Δt_i gives:

$$\Delta t_i = q/130{,}500 = WC\Delta T_i/130{,}500$$
$$= (30{,}000C)(20)/130{,}500 = 4.60C$$

From the preceding equation, the cooling water temperature corresponding to each assumed glycol temperature is calculated, as shown in Table 2.

13. Tube Wall Temperatures (for viscosity correction factor calculation): It is common practice to ignore the temperature drop through the metal of the tube itself, as this value is usually negligible when compared to the inside and outside surface film resistances. Therefore, t_w (*outside*) = t_w(*inside*) = t_w. The relations for t_w, the fluid temperatures, and the tube surface film heat transfer coefficients are shown below:

$$t_w = T_a - \left(\frac{h_o}{h_o + h_{io}}\right)(T_a - t_a)$$
$$= t_a + \left(\frac{h_{io}}{h_o + h_{io}}\right)(T_a - t_a)$$

But h_o and h_{io} cannot be calculated until ϕ_s and ϕ_t are known, and ϕ_s and ϕ_t depend upon the values of t_w. Therefore, the first determinations for t_w assume that $\phi_s = \phi_t = 1.0$. This assumption will be checked at a later stage of the calculations. Values for t_w assuming no viscosity factor correction are shown in Table 3.

14. Viscosity Correction Factor, Tube Inside Surface: These are calculated for each of the assumed glycol temperatures using t_w from Table 3, and the following relationship:

$$\phi_t = (\mu_t/\mu_{tw})^{0.14}$$

The above allows the calculation of h_{io} from:

$$h_{io} = (h_{io}/\phi_t)\phi_t$$

Table 4 shows the calculation of ϕ_t and h_{io}.

Table 3—"Step-Wise" Solution for Tube Wall Temperatures (Not Corrected for Viscosity)

Glycol Temp. T_a	Water Temp. t_a	$T_a - t_a$	h_o/ϕ_s	h_{io}/ϕ_t	$\left[\frac{h_o/\phi_s}{h_o/\phi_s + h_{io}/\phi_t}\right]$	Tube Wall Temperature t_w
(1)	(2)	(3)	(4)	(5)	(3)	(3)
300	110.0	190	904	253.0	0.782	151.2
280	106.3	174	904	212.5	0.811	138.9
260	102.7	157	904	186.1	0.829	129.7
240	99.2	141	904	161.2	0.848	120.3
220	95.8	124	904	142.7	0.863	112.8
200	92.4	108	904	123.4	0.880	105.0
180	89.1	91	904	100.1	0.900	98.2
160	86.0	74	904	66.5	0.932	91.1

Notes: (1) From Step 9; (2) From Table 2; (3) From Step 13; (4) From Step 11; (5) From Table 1

15. Viscosity Correction Factor, Tube Outside Surface: Since the "step-wise" procedures are not used on the shell-side, the following are calculated from the arithmetic average of terminal properties and conditions.

$$t_w = t_{as} + \frac{h_{io}(ave)}{h_o/\phi_s + h_{io}(ave)}(T_{as} - t_{as})$$
$$= 98 + \frac{127.3}{904 + 127.3}(230 - 98)$$

$t_w = 114.7°$ F.

where:

$t_{as} = 98°$ F. (See Step 11)
$T_{as} = (T_1 + T_2)/2 = (300 + 160)/2 = 230°$ F.
$h_{io}(ave) = 127.3$ (From Table 4)
$h_o/\phi_s = 904$ (See Step 11)

therefore:

$$\phi_s = (\mu_s/\mu_{sw})^{0.14} = (0.75/0.64)^{0.14} = 1.0225$$

where:

Viscosity of water at 98° F. = 0.75 centipoise
Viscosity of water at 114.7° F. = 0.64 centipoise

then:

$$h_o = (h_o/\phi_s)(\phi_s) = (904)(1.0225)$$
$$= 925 \text{ Btu/(hr)(° F)(ft²)}$$

It will be noted that using 904 instead of 925 for h_o makes an error on only 0.4° F. for t_w and less than one percent error for ϕ_t in Table 4. Therefore, the values for t_w and ϕ_t do not need to be recalculated due to the assumption that $\phi_t = \phi_s = 1$ in Step 13.

Table 4—"Step-Wise" Calculation of Glycol Viscosity Correction Factor and Heat Transfer Coefficient

Glycol Temp. T_a	Tube Wall Temp. t_w	Viscosity at T_a μ_t	Viscosity at t_w μ_{tw}	(μ_t/μ_{tw})	$\phi_t = (\mu_t/\mu_{tw})^{0.14}$	h_{io}/ϕ_t	Corrected Glycol Heat Transfer Coeff. $h_{io} = (h_{io}/\phi_t)\phi_t$
(1)	(2)	(3)	(3)	(4)	(4)	(5)	(4)
300	151.2	1.48	7.76	0.191	0.793	253	201
280	138.9	1.96	9.15	0.214	0.806	212.5	171.2
260	129.7	2.49	10.58	0.235	0.817	186.1	152.1
240	120.3	3.05	12.59	0.242	0.820	161.2	132.2
220	112.8	3.68	14.33	0.257	0.827	142.7	118.0
200	105.0	4.38	16.63	0.263	0.830	123.4	102.5
180	98.2	5.42	18.80	0.288	0.840	100.1	84.1
160	91.1	7.41	21.03	0.352	0.864	66.5	57.4
						Total =	1018.5

h_{io} (*ave*) = 1018.5/8 = 127.3*

*This value used only for the initial calculation of ϕ_s (see Step 15)
Notes: (1) From Step 9; (2) From Table 3; (3) *CP* (from Fig. 2) x 2.42 = μ; (4) From Step 14; (5) From Table 1

16. Upon completion of the preceding steps, it is possible to proceed to the "step-wise" calculation of total heat transfer surface area, as shown in Table 5. The incremental areas corresponding to the incremental temperatures from Step 9 are calculated from the basic equation:

$$\Delta A = q/U_D \Delta t_m F_T$$

where:

$$\Sigma \Delta A = A$$

Calculations for Δt_m are based on the arithmetic mean using water terminal conditions and glycol incremental temperatures as follows:

$$\Delta t_m \text{ (first glycol increment)} = \frac{(300 - 110) + (280 - 86)}{2} = 192^\circ \text{ F.}$$

A more rigorous method of calculations, not employed here, would involve the use of t_a values from Table 2 instead of water terminal conditions.

The incremental overall heat transfer coefficients are derived as follows:

$$1/U_C = 1/h_o + 1/h_{io} = (h_o + h_{io})/h_o h_{io}$$
$$U_C = h_o h_{io}/(h_o + h_{io})$$
$$1/U_D = 1/U_C + R_d$$

where:

$$R_d = 0.003 \text{ (hr) (ft}^2\text{) (}^\circ\text{ F)/Btu} = \text{dirt and fouling factor}$$

The total heat transfer surface area required for 3,144,000 Btu/hr. under the conditions of the problem is calculated to be 367 sq. ft. (Table 5) as compared to the 383 sq. ft. actually provided (Step 7). It is interesting to note that if the viscosity corrections ϕ_t and ϕ_s had been neglected, the calculated total area would have amounted to 323 sq. ft., or a reduction of approximately 12%. In other words, the unit actually would have been undersized by 44 sq. ft. if these viscosity corrections had not been considered.

Calculation of Exchanger Pressure Drop

The detailed calculations required for the tube-side fluid pressure drop (not including the tube returns) are shown in Table 6, and were based on the formula given by Kern[2] as shown below:

$$\Delta P_t = \frac{f_t L n G_t^2}{(5.22)(10^{10}) D s \phi_t} \text{ psi}$$

A fixed portion of the total effective tube length must correspond to each temperature increment chosen during the "step-wise" calculation of heat transfer area.

Total effective tube length is derived from actual exchanger dimensions as follows:

$$Ln = \frac{An}{a'' N_t} = \frac{(383)(4)}{(0.1963)(122)} = 64.0 \text{ ft.}$$

Correspondingly, the incremental tube length equivalent to an incremental amount of heat transfer surface as shown in Table 5 is:

$$\Delta Ln = (\Delta A^*/\Sigma \Delta A^*) Ln = (\Delta A^*/354.1) 64.0 = 0.1807 \Delta A^*$$

It will be noted that the "uncorrected" areas from Table 5 (ΔA^* and $\Sigma \Delta A^*$) are used in this step in order to obtain the proportional relationship between the different area increments for the calculation of the incremental pressure drops in the exchanger tubes. Values for ΔLn and the corresponding ΔP_t are calculated and shown in Table 6.

Tube-side return pressure drops are calculated as follows (Kern[2] p 148):

$$\Delta P_r = (4n/s)(V_t^2 \rho_t / 2g\ 144) \text{ psi}$$

The second term of this equation may be calculated, but is more easily solved graphically (Kern[2] p 837) since calculation of the tube-side fluid velocities V_t in Table 1 shows them to be almost constant at 2.00 ft./sec. as the glycol temperature varies from 300° to 160° F. Therefore, for $G_t = 469{,}000$ lb./(hr.)(ft²):

$$(V_t^2 \rho_t / 2g\ 144) = 0.03$$

hence:

$$\Delta P_r = (4)(4)(0.03)/1.045 = 0.46 \text{ psi}$$

The total pressure drop on the tube-side of the exchanger is:

$$\Delta P_T = \Delta P_t + \Delta P_r = 1.88 + 0.46 = 2.34 \text{ psi}$$

The above value of ΔP_T being below the limit of 10 psi, the tube design is satisfactory from this standpoint.

The pressure drop for the shell-side fluid need not be "step-wise" since the pertinent properties of water change very little from 86° to 110° F. This pressure drop can be calculated from the formula presented on page 147 of Kern[2]:

Table 5—"Step-Wise" Calculation of Heat Transfer Surface Required

T_w	h_{io}	h_o	$h_{io}h_o$	$h_{io}+h_o$	U_C	$1/U_C$	$1/U_D$	U_D	U_D(use)	q	Δt_m	ΔA^*
(1)	(2)	(3)	(4)	(4)	(4)	(4)	(4)	(4)			(4)	(4)
300	201	925	187,000	1131	165.3	0.00604	0.00904	110.7				
									105.9	480,000	192	23.6
280	171.2	925	159,200	1101.2	144.7	0.00691	0.00991	101.0				
									97.4	469,000	172	28.0
260	152.1	925	141,600	1082.1	130.8	0.00765	0.01065	93.8				
									89.8	459,000	152	33.7
240	132.2	925	122,900	1062.2	115.7	0.00864	0.01164	85.8				
									82.8	449,000	132	41.1
220	118.0	925	109,700	1048.0	104.7	0.00955	0.01255	79.7				
									76.0	439,000	112	51.7
200	102.5	925	95,300	1032.5	92.2	0.01086	0.01386	72.2				
									67.4	428,000	92	69.2
180	84.1	925	78,200	1014.1	77.1	0.01298	0.01598	62.6				
									54.6	419,000	72	106.8
160	57.4	925	53,400	987.4	54.2	0.01846	0.02146	46.6				

Total calculated heat transfer area uncorrected by F_T = 354.1 ft²

*$A = \Sigma \Delta A^*/F_T = 354.1/0.965 = 367$ sq. ft. = Total calculated required heat transfer area

Notes: (1) From Step 9; (2) From Table 4; (3) From Step 15; (4) From Step 16

Table 6—"Step-Wise" Calculation of Tube-Side Pressure Drop, Not Including Tube Returns

Glycol Temp. T_w	Re_t	Friction Factor f_t	G_t	G_t^2	ϕ_t	Glycol Gravity s	ΔA^*	ΔLn	$f_t(ave)$	D	$s(ave)$	$\phi_t(ave)$	ΔP_t
(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)		(9)			(10)
300	16,400	0.000240	469,000	$22(10^{10})$	0.793	1.008							
							23.6	4.27	0.000249	0.0517	1.013	0.799	0.106
280	12,370	0.000258	469,000	$22(10^{10})$	0.806	1.017							
							28.0	5.06	0.000264	0.0517	1.022	0.812	0.131
260	9,750	0.000270	469,000	$22(10^{10})$	0.817	1.027							
							33.7	6.09	0.000279	0.0517	1.031	0.819	0.164
240	7,950	0.000289	469,000	$22(10^{10})$	0.820	1.035							
							41.1	7.43	0.000298	0.0517	1.040	0.824	0.210
220	6,590	0.000308	469,000	$22(10^{10})$	0.827	1.045							
							51.7	9.35	0.000314	0.0517	1.049	0.828	0.275
200	5,530	0.000319	469,000	$22(10^{10})$	0.830	1.054							
							69.2	12.50	0.000331	0.0517	1.059	0.835	0.382
180	4,470	0.000343	469,000	$22(10^{10})$	0.840	1.063							
							106.8	19.30	0.000354	0.0517	1.068	0.850	0.850
160	3,270	0.000365	469,000	$22(10^{10})$	0.864	1.072							

Total $\Delta P_t = 1.882$

Notes: (1) From Step 9; (2) From Table 1; (3) Kern[3] p 836; (4) From Step 8; (5) From Table 4; (6) From Figure 1; (7) From Table 5; (8) From "Step-Wise" Pressure Drop Section; (9) From Step 8; (10) From "Step-Wise" Pressure Drop Section

Fig. 3—Standard Approximation Method—Heat Transfer Area

Tube-Side—Hot—Glycol

$a' = 0.302$ sq. in./tube

$$a_t = \frac{N_t a'}{144n} = \frac{86(0.302)}{144(4)} = 0.0451 \text{ ft}^2$$

$$G_t = \frac{W}{a_t} = \frac{30{,}000}{0.0451} = 666{,}000 \text{ lb./(hr)(ft}^2\text{)}$$

$$V_t = \frac{G_t}{3600\rho_t} = \frac{666{,}000}{3600(62.5)(1.045)}$$

$= 2.84$ ft./sec

$$Re_t = \frac{DG_t}{\mu_t} = \frac{(0.62/12)666{,}000}{1.50(2.42)} = 9{,}370$$

$L/D = 16/(0.62/12) = 310$

$j_{Ht} = 35$ (Kern[3] p834)

$C = 0.747$ at 230° F (Fig. 1)

$k_t = 0.144$ at 230° F (Fig. 1)

$D = 0.62/12 = 0.0517$ ft.

$D_e = 0.75/12 = 0.0625$ ft.

$D/D_e = 0.0517/0.0625 = 0.827$

$\mu_t = 1.50(2.42) = 3.64$ lb./(ft) (hr)

$$h_{io}/\phi_t = j_{Ht}\left(\frac{k_t}{D}\right)\left(\frac{C\mu_t}{k_t}\right)^{1/3}\left(\frac{D}{D_e}\right) = 217$$

Proceed to shell-side to find t_w needed to calculate the value of ϕ_t.

Calculation of ϕ_t:

$\mu_{tw} = 5.0$ centipoises at $t_w = 122°$ F.

$$\phi_t = \left(\frac{\mu_t}{\mu_{tw}}\right)^{0.14} = \left(\frac{1.5}{5.0}\right)^{0.14} = 0.85$$

$$h_{io} = (h_{io}/\phi_t)\phi_t = 217(0.85) = 184.2$$

Shell-Side—Cold—Water

$B = 7$ in. baffle spacing

$$a_s = \frac{ID_s C' B}{144P_T} = \frac{13.25(0.25)(7)}{144(1.0)} = 0.1610 \text{ ft}^2$$

$$G_s = \frac{w}{a_s} = \frac{130{,}500}{0.1610} = 811{,}000 \text{ lb./(hr)(ft}^2\text{)}$$

$\mu_s = 0.75(2.42) = 1.814$ lb./(ft)(hr) at 98° F.

$D_e = 0.73/12 = 0.0608$ ft.

$$Re_s = \frac{D_e G_s}{\mu_s} = \frac{(0.0608)811{,}000}{1.184} = 27{,}200$$

$j_{Hs} = 97$ (Kern[3] p 838)

$$V_s = \frac{G_s}{3600\rho_s} = \frac{811{,}000}{3600(62.5)(1.0)} = 3.61 \text{ ft./sec.}$$

$c = 1.0$ at 98° F.

$k_s = 0.36$ at 98° F.

$$h_o/\phi_s = j_{Hs}\left(\frac{k_s}{D_e}\right)\left(\frac{c\mu_s}{k_s}\right)^{1/3} = 985$$

Note: Tube metal thermal resistance considered to be zero

$$t_w = T_{av} - \frac{h_o/\phi_s}{h_o/\phi_s + h_{io}/\phi_t}(T_{av} - t_{av})$$

$= 122°$ F.

$\mu_{av} = 0.61$ centipoises at 122° F.

Calculation of ϕ_s:

$$\phi_s = \left(\frac{\mu_s}{\mu_{av}}\right)^{0.14} = \left(\frac{0.75}{0.61}\right)^{0.14} = 1.0294$$

$h_o = (h_o/\phi_s)\phi_s = 985(1.0294) = 1012$

Fig. 4—Standard Approximation Method—Pressure Drop

Tube-Side—Hot—Glycol

$Re_t = 9,370$

$f_t = 0.00028$

$s = 1.045$ (ave. at 230° F)

$G_t = 666,000$ lb./(hr.)(ft²)

$D = 0.62/12 = 0.0517$ ft.

$L = 16.0$ ft.

$n = 4$ passes

$\phi_t = 0.85$

$$\Delta P_t = \frac{f_t L n G_t^2}{(5.22)(10^{10}) D s \phi_t} = 3.31 \text{ psi}$$

$$\Delta P_r = \left(\frac{4n}{s}\right)\left(\frac{V_t^2 \rho_t}{2g\ 144}\right) = 0.92 \text{ psi}$$

where: $\left(\frac{V_t^2 \rho_t}{2g\ 144}\right) = 0.06$ (Kern[3] p 837)

$\Delta P_T = \Delta P_t + \Delta P_r = 3.31 + 0.92 = 4.23$ psi

Shell-Side—Cold—Water

$Re_s = 27,200$

$f_s = 0.0017$

$s = 1.0$

$G_s = 811,000$ lb./(hr.)(ft²)

$D_s = 13.25/12 = 1.104$ ft.

$N + 1 = 12L/B = 12(16)/7 = 27$

$D_s = 0.0608$ ft.

$\phi_s = 1.0294$

$$\Delta P_s = \frac{f_s G_s^2 D_s (N+1)}{(5.22)(10^{10}) D_e s \phi_s} = 10.1 \text{ psi}$$

ΔP_s = is acceptable.

$$\Delta P_s = \frac{f_s G_s^2 D_s (N+1)}{(5.22)(10^{10}) D_e s \phi_s} = 9.38 \text{ psi}$$

where:

$Re_s = 23,620$

$f_s = 0.0018$ ft²/in² for bundles with 25% cut segmental baffles

$s = 1.00$

$D_e = 15.25/12 = 1.27$ ft.

$\phi_s = 1.0225$

$N + 1 = 12L/B = (12)(16)/7 = 27$ (number of crosses)

$G_s = 705,000$ lb./(hr.)(ft²)

$D_s = 0.73/12 = 0.0608$ ft.

This calculated value for the shell-side pressure drop is acceptable since it is less than the allowable value of 10 psi.

Meet the Author

Edward R. Grahl joined E. I. du Pont de Nemours & Co. in 1953 where he has been engaged in technical service and plant assistance work for their Wilmington, Del. Engineering Dept. He graduated from Clarkson College of Technology with a B. S. in chemical engineering in 1945, and received their Professional Degree in 1952. In 1949 he received a Master's Degree in Industrial Management from New York University. Joining the Celanese Corp. of America in 1945, he worked with pilot plant development and later in the Engineering Research and Development Dept. From 1947 to 1953 he was with the Foster Wheeler Corp. Process Development Div. engaged in the design of chemical plants and processes. Mr. Grahl is a licensed Professional Engineer in the states of New York and New Jersey.

Comparison of "Step-Wise" to Standard Approximation Method for Heat Transfer Surface

Now consider the circumstances if "step-wise" calculations are *not* employed. Even though the viscosity plot for 90 wt.% ethylene glycol (Fig. 1) shows a 5.5-fold increase from 300° to 160° F.; for comparative purposes, the total heat transfer surface will now be calculated by the standard approximation method discussed earlier, using fluid terminal properties.

Similarly to the "step-wise" calculations:

$Q = 3,150,000$ Btu./hr.

$w = 130,500$ lb./hr. cooling water

$\Delta_t = (123)(0.965) = 118.7°$ F.

Assume the value of U_D to be 86 (based on experience or a previous trial calculation). Therefore, the heat transfer area (first approximation) is:

$A = 3,150,000/(86)(118.7) = 308$ sq. ft.

$N_t = A/La'' = 308/(16)\ (0.1963) = 98$

For the assumed four tube passes, the tube-count table gives:

$N_t = 86$ for $ID_s = 13.25$ in.

$A = (86)(16)(0.1963) = 270$ sq. ft.

U_D (*corrected*) $= 3,150,000/(270)(118.7)$

$= 98.2$ (acceptable)

Calculating average temperatures which will be used through the remainder of the standard approximation calculations*:

$T_{av} = (300 + 160)/2 = 230°$ F.

$t_{av} = (110 + 86)/2 = 98°$ F.

Using the immediately preceding data, the standard approximation method calculation of heat transfer area is continued in Fig. 3.

Continuing the calculations from Fig. 3, the heat transfer coefficients are determined as follows:

Clean overall coefficient of heat transfer:

* The use of "caloric temperatures" gives a more rigorous result.[3]

$$U_c = \frac{h_{io}h_o}{h_{io}+h_o} = \frac{1012(184.2)}{184.2+1012} = 156.0 \text{ Btu/(hr)(ft}^2\text{)(°F)}$$

Design overall coefficient of heat transfer:

$$U_D = Q/A\Delta t = 3,150,000/(270)(118.7) = 98.2 \text{ Btu/(hr)(ft}^2\text{)(°F)}$$

Combined dirt and fouling factor:

$$R_d = \frac{U_c - U_D}{U_c U_D} = \frac{156.0 - 98.2}{98.2(156.0)} = 0.0038 \text{(hr)(ft}^2\text{)(°F)/Btu}$$

Since the dirt factor, R_d, is larger than the 0.003 required by the problem, it indicates that the exchanger is slightly too large, but it is not large enough so that a smaller exchanger could be selected. Note, however, that the required heat exchange area calculated by the standard approximation method is slightly under 270 sq. ft., while that calculated by the "step-wise" method is 367 sq. ft.

Therefore, calculation by the standard approximation method gives an exchanger "under-designed" by about 26.5%. This could lead to serious consequences in the actual operation of a process plant.

Comparison of "Step-Wise" to Standard Approximation Method for Exchanger Pressure Drop

Now the exchanger tube and shell-side pressure drops will be calculated by the use of the standard approximation method utilizing average terminal conditions as shown in Figure 4. It will be recalled that this exchanger is one size (shell diameter) smaller than that selected by the "step-wise" calculation method.

Discussion of Results

A detailed illustrative example of "step-wise" calculations versus the standard approximation method (based on fluid stream terminal conditions) has shown a 15.25 in. shell ID unit is required to fulfill the heat duty, whereas the standard approximation method indicates the need for only a 13.25 ID unit. Because the physical and thermal data were carefully compiled and because the "step-wise" method considers significant incremental changes in fluid properties, it appears only reasonable to presume that the results of the "step-wise" calculations are the more reliable. Figure 5 shows the highlights of the results.

If the smaller exchanger were installed it would provide only about 73.5% of the total heat exchange area required. In all probability this would necessitate the installation of a parallel unit, or a complete replacement of the "under-designed" exchanger. Until this second unit could be installed, process "on-stream" time would be lost or reduced proportionally. In either case, the added expense incurred because of "under-design" cannot be justified when one considers the nominal extra cost of developing an adequate design from the start. In those instances where larger surfaces and/or more costly materials of construction are required, the justification for "step-wise" calculations is even stronger.

Acknowledgment

The author wishes to thank Dr. D. Q. Kern, Director of Engineering, The Colonial Iron Works Co., for his helpful comments in the review of this article. Dr. Kern's text, *Process Heat Transfer*, served as a basis for form of presentation and nomenclature.

References

(1) Carbide and Carbon Chemical Corp., *Bull. No. F-4763B*, "Glycols"
(2) Kern, D. Q., *Process Heat Transfer*, 1st ed., (1950) McGraw-Hill Book Co., New York, N. Y.
(3) Colburn, A. P., *Ind. Eng. Chem.*, 35, 873-877 (1933)
(4) *Standards of Tubular Exchanger Manufacturers Association* 3rd ed., (1952) New York, N. Y.

Fig. 5—Comparison of "Step-Wise" to Standard Method

	"Step-Wise" Method		Standard Method	
	Tube-Side	Shell-Side	Tube-Side	Shell-Side
1 Pressure drop, psi				
Calculated	2.34	9.38	4.23	10.1
Allowable	10.	10.	10.	10
2 h_i, Btu/(hr) (ft²) (°F)	127.3 (ave)	925	184.2	1012
3 U_c, Btu/(hr) (ft²) (°F)	110.6 (ave)		156.0	
4 U_D, Btu/(hr) (ft²) (°F)	82.0 (ave)		98.2	
5 R_d, (hr) (ft²) (°F)/Btu				
Calculated	0.003		0.0038	
Required	0.003		0.003	
6 Shell ID, in.	15.25		13.25	
7 Number of tubes	122		86	
8 Heat transfer area, ft²				
Calculated	367		270	
Provided	383		270	

Answers to Problems in

Low Capacity Flow Control

By JOHN PROCOPI
Milton Roy Co.

THROUGHOUT petroleum processing operations, controlled volume pumps can provide a solution to many low capacity flow control problems. As flow controllers, they simultaneously meter and pump small amounts of additives, defoamers, inhibitors, and other treating chemicals.

As ratio controllers, they are used for example to maintain a fixed relationship between an additive and a finished gasoline or a fuel oil stream. As final control elements in process instrumentation, they can contribute to accurate regulation of process variables.

The capacity of a controlled volume pump can be expressed by the general equation:

$$Q = (D^2LNE)/K$$

where: Q = Pump capacity.
D = Plunger diameter, inches.
L = Plunger stroke length, inches.
N = Number of strokes per minute.
E = Volumetric efficiency.
K = Dimensional constant.

If D and L are in inches and N is in strokes per minute, as indicated, the following table shows the value of K for obtaining Q in various flow units:

Q	K
gal. per hour	4.92
gal. per min.	295.
ml. per hour	0.0013

Data accumulated from thousands of actual pump installations indicate that the volumetric efficiency, E, of any specific pump is predictable within an accuracy of ±1%. This repetitive accuracy is relatively unaffected by wide variations in viscosity, density, and pressure drop in the system. A value of 0.9 for E is satisfactory for preliminary calculations.

The general equation given above shows the effect of the three major variables which influence controlled volume pumping capacity. Plunger diameter, D, is of course fixed for each specific installation. However, capacity varies linearly with changes in either stroke length or pump speed.

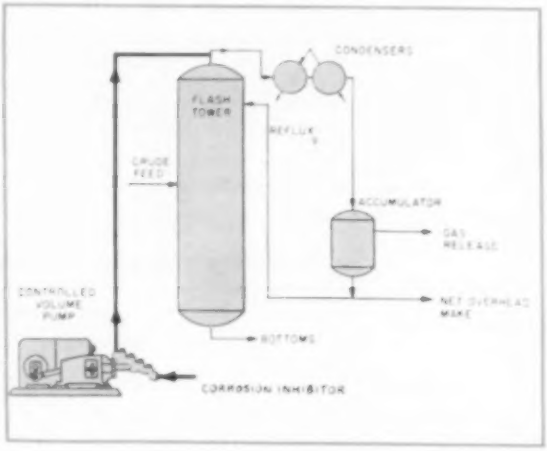
There are many methods of effecting this variation, ranging from simple manual adjustment of stroking length or speed up to completely automatic adjustment by means of a control air signal or an electric signal from instrument controllers.

Injecting Corrosion Inhibitor

The system for injection of a corrosion inhibitor illustrated in the drawing typifies the simplicity with which small quantities of additives can be metered to many constant throughput processes.

These basic open loop chemical feeding systems rely upon the accuracy of controlled volume pumps to maintain the fixed ratio of additive to main stream flow. Manual stroke length adjustment easily accommodates occasional changes in the process conditions. In this particular installation, approximately 3 gal./hr. of the corrosion inhibitor is being added to the vapor stream effluent at the top of the flash tower, serving to reduce the possibilities of corrosion in the overhead condenser system.

Thus a constant supply at the desired flow rate is provided of the inhibitor, which forms and maintains a protective film coating on the metallic surfaces exposed to corrosive agents in the product stream.

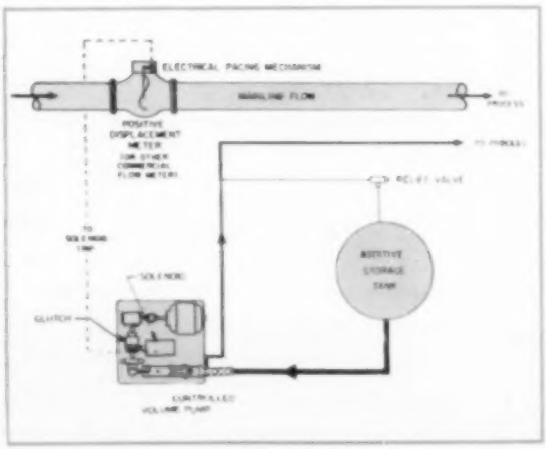


Injecting Fuel Oil Additives

Flow control of small volumes of fuel oil inhibitor—for example, 1 gal. per 4000 gal. of oil—is illustrated by the proportional feed system shown in the sketch.

The main line flow rate of the process is measured by a positive displacement meter, or other commercial flow meter, and the electrical impulses are transmitted in proportion to this flow rate. The electrical signal energizes a solenoid, thereby engaging a clutch on the controlled volume pump.

The pump will then complete one suction-discharge cycle and return to exactly the original position. Upon receiving the next signal from the electrical pacing mechanism, the pump will again discharge a controlled volume of additive into the main line stream. This system is also used for adding octane appreciator to gasoline at pipe line distribution stations.

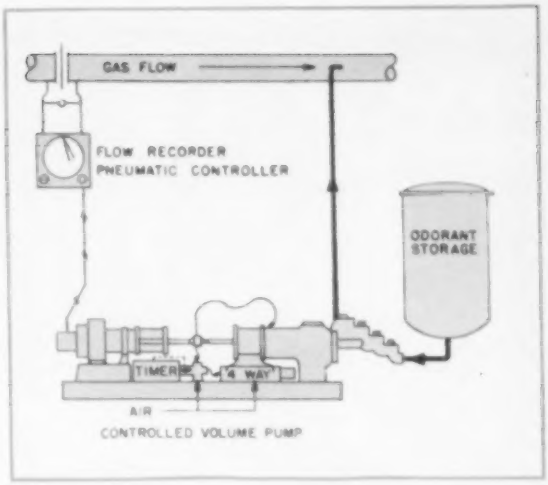


Gas Odorizing

Controlled volume pumps can conserve chemicals in many applications where the flow rate of small quantities of relatively expensive additives must be controlled accurately in proportion to system throughput. In the accompanying drawing, an air-operated pump acts as the final control element in a natural gas odorization system.

A pneumatic flow controller on the natural gas line transmits a 3-15 psi. control air (or natural gas) signal to the pump in direct proportion to flow. This signal causes a positioner to reset a pneumatic piston operator which adjusts the pump stroke length.

For example, an increase in natural gas flow rate results in an automatic increase in stroke length of the pump, thus maintaining the fixed relationship of additive to natural gas. If an occasional change in the basic ratio is desired, it can be effected by manually increasing or decreasing the pumping speed to a new value.



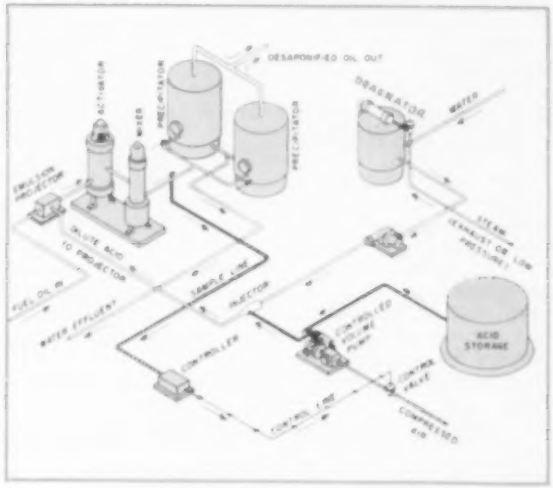
Desaponification System

Another system in which an air-operated, controlled volume pump is used as a final control element is illustrated in the accompanying sketch.

In this process, sodium naphthenate soaps are removed from residual fractions of coastal crude oils. Caustic solution is first added to the crude to reduce the acid number. After processing of the oil is completed, however, the sodium must be removed because its presence in the fuel oil contributes materially to increased ash content.

A 3-15 psi. control air signal from an oil-to-water flow ratio controller positions a diaphragm motor valve so as to throttle the natural gas stream which drives the sulfuric acid pump.

The dilute acid and the oil are blended, emulsified, and separated in this desaponification process. The resulting naphthenic acids remain in the fuel oil. The mineral salts are removed in the aqueous phase.

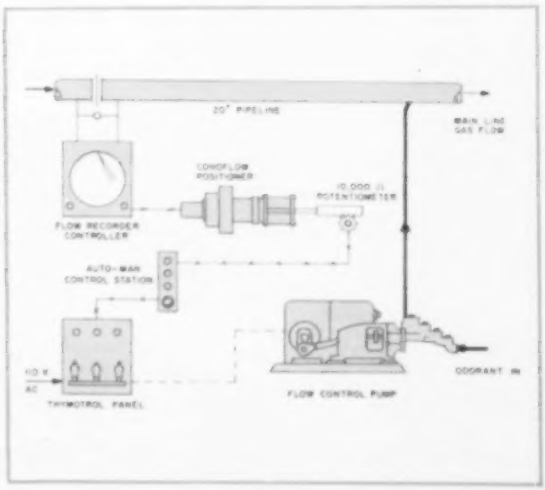


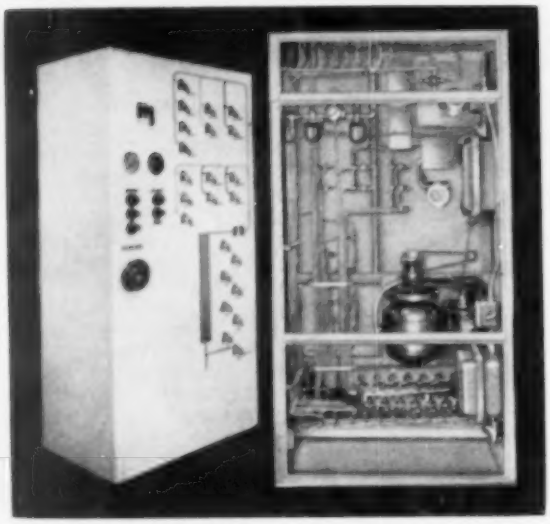
Injection of an Odorant

The accompanying drawing illustrates an injection system for odorants which effects accurate flow of the material as main line gas flow rate varies.

Flow rate of the natural gas is metered by a standard flow recorder controller that has a lineal air signal output in proportion to the flow rate. This 3-15 psi. control air signal is sent to a pneumatic piston operator, which is linked mechanically to a standard 10,000-ohm potentiometer in the control circuit of a General Electric "Thymotrol" panel.

Thus, the variable current output of the Thymotrol powering the pump motor is directly proportional to the gas flow rate in the pipe line. As flow rate increases, the flow control pump plunger speed increases; and as flow rate decreases, the plunger speed decreases. Flow ratio of odorant to gas is set initially by screw adjustment of the pump stroke length and is readily adjustable to any desired variable.





GRAPHIC TYPE CONTROL PANEL used in continuous process: rear view at right

Continuous Polymerization

Completely automatic control using air-powered controlled volume pumps as flow-control instruments, ratio controllers, and final control elements is exemplified in an installation of 23 such pumps on a continuous polymerization process.

In this process, various chemical streams are combined continuously, homogenized, and then pumped to the polymerization reactor in proper proportions. In addition to exacting flow control requirements, many other conditions are met. Some of these include:

1—Centralized control though one panel of all process pumps, which are widely separated in a four-story building. (See photo of panel.)

2—A record, by a cumulative check on quantities pumped, of total daily production.

3—Monitoring the chemical stream pumps so that at any time a standby pump can be inserted in the line as a replacement without disturbing overall flow of the chemical.

4—Additional independent and automatic controlled regulation of the catalyst pumps in accordance with the temperatures in the continuous reactor.

Process capacity is regulated by a large handwheel which adjusts the stroking rate for all the controlled volume pumps. The handwheel actually regulates a mechanical speed changer which acts through a gear reducer to drive a cam shaft, as shown in the photograph. All pumps are actuated from this shaft by their own individual pilot air valves. Any pump can be cut out of the line.

Each pump is calibrated to deliver the exact amount of fluid required in the process when all pumps are operated at 30 strokes/minute. Different capacities for any given requirement, however, can be achieved by adjusting speed of the output shaft of the speed changer. The speed of the output shaft is indicated by a gage on the panel face, while the counter above the gage totals the actual revolutions of the camshaft.

The total daily production is easily checked by reading this tachometer counter. Since all pumps are controlled from the one camshaft, and are operated at a certain total process capacity, multiplying camshaft revolutions by system capacity will determine the throughput.

After all these chemical streams have been properly blended, homogenized, and fed into the reactor; process control is effected through close regulation of the temperature. Once the reaction has started, catalyst feed is very carefully controlled to maintain a proper temperature in the reactor. A temperature controller transmits a 3-15 psi. control air signal to the final control element—a controlled volume pump of the "Airoymetric" type—on the catalyst slurry feed.

Typical Applications for Controlled Volume Pumps in Low Capacity Control

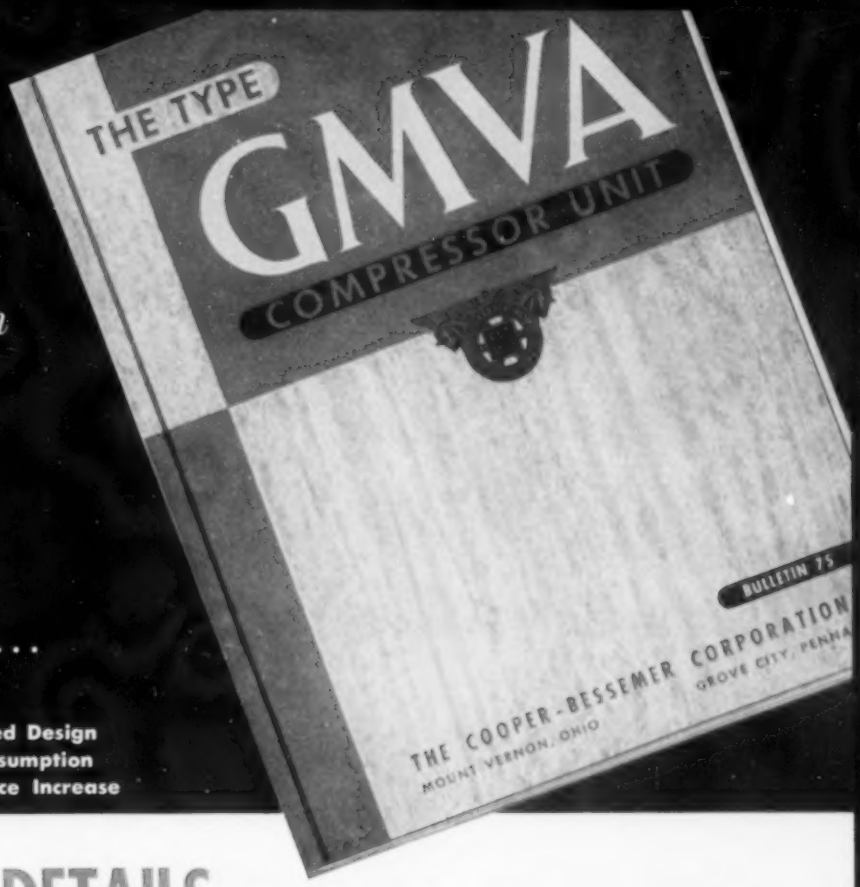
Process or Operation	Fluid Pumped	Purpose
Boiler feed water treatment	Sodium Sulfite, Phosphates	Remove residual oxygen and water hardness producing minerals (calcium and phosphate) thereby prolonging boiler and turbine life
Cooling tower treatment	98 percent sulfuric acid	Close control of pH of cooling tower water prevents internal and surface deterioration of cooling tower wood
Vacuum distillation	Anti-foam agent	Metering of anti-foam agent to suction side of charge pump minimizes foaming problem in vacuum distillation tower
Platforming	Make-up caustic	Metered addition of make-up caustic assures efficient scrubbing of hydrogen sulfide from recycle hydrogen going to the charge furnace
Research	Varied	Charge to pilot units easily controlled by Controlled Volume Pumps, facilitating studies
Corrosion inhibition	Kontol or other corrosion inhibitor	Metered addition of corrosion inhibitor into process streams and tower tops safeguards processing equipment against attack by organic and inorganic acids, hydrogen sulfide, carbon dioxide and brine
Fuel oil treating	Oxidation inhibitors	Addition of polymerization inhibitors minimizes formation of gumming polymers in fuel oil
Crude desalting	Deemulsifying agents	Controlled addition of deemulsifiers assures efficient separation of desalted crude from brine solution
Finished gasoline treating	Inhibitors	Metering of inhibitors to finished gasoline streams going to tank farms
Octane appreciation	Octane appreciators	Accurate, in-line blending of octane appreciators and gasoline at pipeline distribution stations and in refineries
Lube oil treating	Caustic soda	Efficient removal of naphthenes and acids from lube oil
Desaponification of fuel oil	Concentrated black sulfuric acid	Reduction of ash content of fuel oil by removing sodium naphthenates
Acid treating	Concentrated sulfuric acid	Accurate metering of concentrated sulfuric acid for decolorizing distillates and lube oils

New Economy with the new

GMVA

compressor...

- **Improvements on an Accepted Design**
- **10% Reduction in Fuel Consumption**
- **Added Horsepower, No Space Increase**



TO GET THE DETAILS...

send for your Fact-Filled copy of Cooper-Bessemer Bulletin 75

Now, Cooper-Bessemer offers Bulletin 75 as your complete guide to the new GMVA gas engine-driven compressor. Taking the many desirable features of the accepted and industry-proven GMV . . . . plus *big* improvements in engine design and construction . . . . Cooper-Bessemer presents the GMVA bringing *even greater* economy and dependability to the 540-1350 horsepower range.

In this 22-page Bulletin you will find information on such subjects as: V-angle design advantages, streamlined scavenging and lubrication, cooling systems, automatic controls, double deck compressor valves, engine cutaway drawings and photographs of typical installations.

To learn of these and other important GMVA advantages, just mail the coupon, or write to The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

MOUNT VERNON, OHIO
COOPER-BESSEMER
GROVE CITY, PENNA.

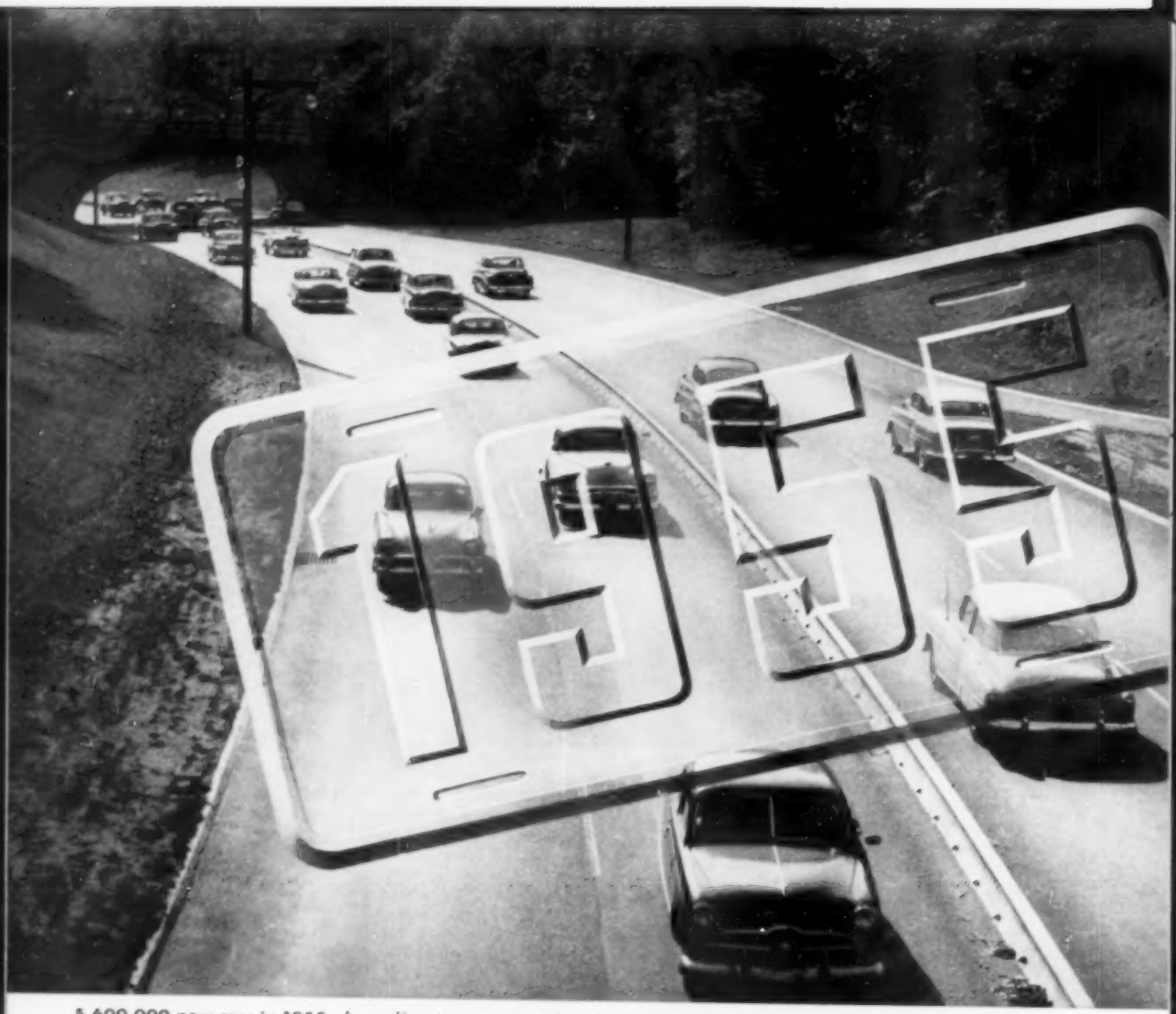
New York, N. Y. • Washington, D. C. • Gloucester, Mass. San Francisco, Calif. • Houston, Texas • Seattle, Wash. Los Angeles, Calif • Chicago, Illinois • St. Louis, Mo. San Diego, Calif • New Orleans, Louisiana • Cooper-Bessemer of Canada, Ltd., Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

THE COOPER-BESSEMER CORPORATION 1
Mount Vernon, Ohio

Please send me a copy of Bulletin 75 on the new GMVA compressor unit.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____



5,600,000 new cars in 1955. According to current estimates the automotive industry will build and sell more than five million new passenger cars in 1955. How will your gasolines perform in these new engines throughout the year?

Engineer operates an intricate combination of mechanical, pneumatic, and electronic controls to duplicate road conditions exactly. Here at Ethyl it is possible to create absolutely reproducible tests.

Ethyl Research can help you match your gasoline to the new 1955 cars

What is the best way to be certain that the gasolines you are planning to market this year will give superior antiknock performance in the new 1955 cars—under all driving conditions?

Answer: Look to Ethyl Research.

After twenty-five years' experience in the design, development and improvement of chassis dynamometers for fuel research work, Ethyl Research people have developed three all-weather indoor highways—two at Detroit and the other being constructed at San Bernardino, California. These new test instruments will give you accurate and reproducible knock ratings that have proved far superior to testing on the road.

No traffic impedes the engineers. No sudden shift in the weather upsets the conditions. No shift of crews to other regions for changes in season is needed.

Here in our all-weather rooms, Ethyl research people can control climatic conditions, wind, moisture, temperature and accurately simulate car speeds and road grades. Here experienced crews can work every day of the year, to tell you how your gasoline will behave in the '55 cars on a cold day in Maine, in hot Arizona, in Florida or San Francisco. Every detail of these rooms has been designed to give faster and more accurate evaluation of your gasoline antiknock quality—in any car—under any driving condition.

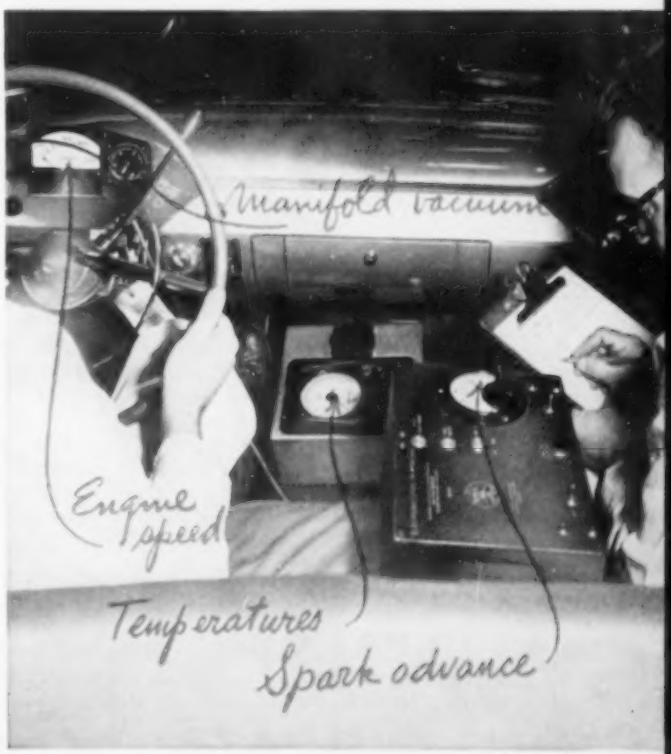
Here production or experimental fuels can be accurately compared to each other or to standard reference fuels.

These unique all-weather rooms are another example of how Ethyl Research is performing a valuable service to refiners.

ETHYL CORPORATION
Research Laboratories

1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

Rear wheels of test car ride on huge rollers that simulate acceleration, hills and other normal driving conditions.



Test engineers check knock and spark advance as car accelerates to "high speed" on one of Ethyl's indoor highways.

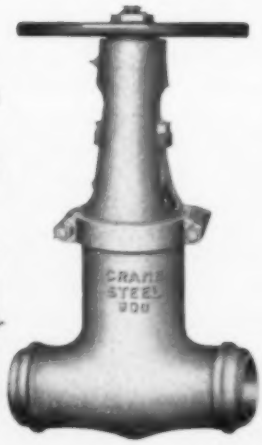
Hold it!—is it good enough for CRANE VALVES?

What you see here is routine procedure on raw materials coming to Crane. There's no unloading of the more than 3,000 incoming carloads per year until the Crane Quality Control Lab gives an unqualified O.K.

The extra care that Crane gives to raw materials, and similarly to every step in manufacturing, pays off in better valves for you. You can be sure that Crane stands for quality that results in lower cost in the long run.

That's another reason why thrifty buyers prefer Crane valves. They know they're investing in better piping performance as well as protecting against untimely and excessive maintenance. A mighty important consideration in these days of high costs. And, surely, the main reason why industry keeps using more Crane valves than any other make.

Better Quality
Bigger Selection
in Valves
for Every Need



CRANE CO.

General Offices: 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

CRANE'S FIRST CENTURY . . . 1855-1955

 (To obtain more data on advertised products see page 108)

Petroleum Processing

JANUARY 1955

Petrochemical Section

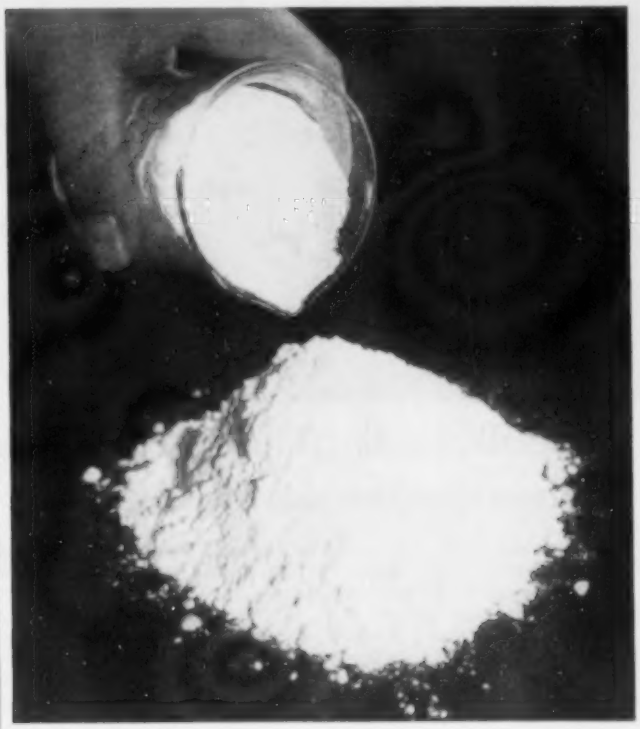
IN THIS SECTION

Enthalpy Changes

Use an equation of state if you have to figure them out says author Weber — p. 83

Know These Words?

Information for you on two familiar terms that are now a part of petrochemicals — nitric acid and latex paints —p. 82



Molecular Sieves

They're a new wrinkle in adsorption—p. 79

In the Departments

Here is a quick spot check method for you to determine the gasoline content of absorber oil — (Plant Practices) p. 87.

Another adsorption improver: silica gel treated with silver nitrate has more selectivity on propane-propylene admixture — (Patents) p. 91.

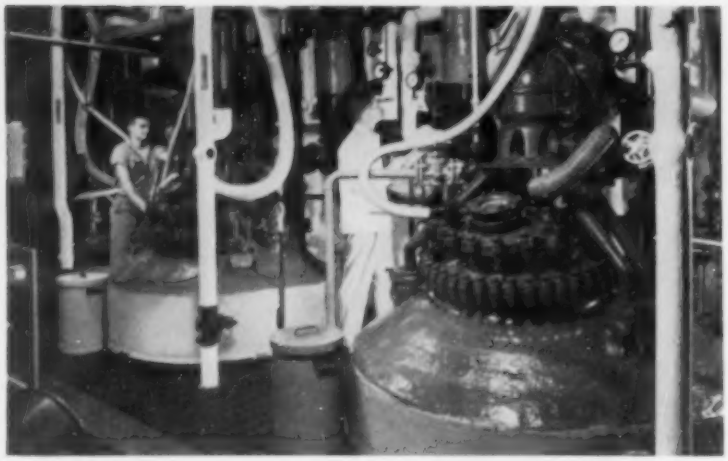
OTHER DEPARTMENTS

Personals	95
Suppliers	99
Meetings	103
Books	105
Information Offered	106
Advertisers' Index	108
What's New!	109
Editorials	140

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.



How DPi, Leading Vitamin E Producer Maintains Absolute Product Purity

Concentrating and purifying Vitamin E from natural vegetable oils is a delicate job. It's the "house specialty" of Distillation Products Industries, a division of Eastman Kodak Company.

By molecular distillation, DPi produces tocopherols in a number of forms. In every phase of their process—particularly the final step—extreme care must be taken to protect these products from contamination.

Critical Stage

The final stage in DPi's preparation of Vitamin E requires the protection of Pfaudler glassed steel reaction kettles. Fortified with an acid-alkali resistant inner surface, these reactors resist all forms of chemical attack, protecting the product from contamination.

Use of Pfaudler glassed steel equipment typifies the care that has made DPi a leader in the research and production of Vitamin E, as well as Vitamin A and distilled monoglycerides.

You too can profit by using Pfaudler glassed steel reactors. They are available in a complete range of capacities, from laboratory to full-scale production. When you make use of the custom features Pfaudler has incorporated in their standard design, you are able to get delivery on these reactors within two weeks.

How to Cool Off a Heat Exchanger Problem

With new processes on the horizon every day, Pfaudler engineers are receiving more and more requests for special features on heat exchangers.

To save you money on these designs, they have found that Pfaudler "flexible standard" stainless steel heat exchangers can be used as the base unit in a high percentage of cases.

For example, nozzles of any size—either flanged or threaded—can be installed in any position. And new production line methods make possible rapid deliveries—as few as 7 days!

To solve your problem, Pfaudler sales engineers can select from a complete line of heat exchangers—fixed tube sheet, single or multipass, tube and/or shell side stainless steel units. Shell diameters range from 4" to 24" in four basic types of construction: fixed tube sheet . . . outside packed floating head design . . . internal floating head . . . U-tube bundle. Most have removable tube bundles.

To take the heat off that heat transfer problem, discuss it with your Pfaudler representative. He has plenty of equipment to choose from.

Tall Story Lies Behind This Canadian Column

Two-thirds of this giant column was fabricated from stainless steel. The rest is carbon steel.

Seventy-seven feet high, the column projects into the sky above Canadian Chemical Company's plant at Edmonton, Alberta. It is a good example of the type of design and fabricating attention your problem will get when you turn it over to Pfaudler engineers.

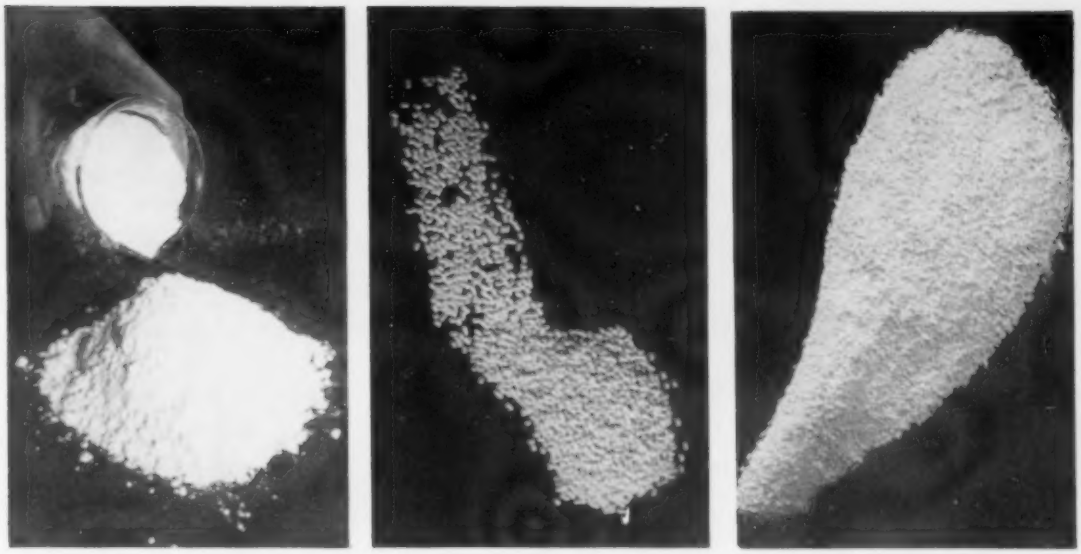
In this case, a column was needed for a big, and very specific type of job. Seventy-seven feet high by 54 inches in diameter, it required custom fabrication.

Giant column has 40 sieve trays, is made of two types of steel.

Ordinarily, Pfaudler engineers are able to use economical standard units to solve problems of distillation, fractionation, stripping, bleaching and absorption. This saves you money, gives you the advantage of interchangeable components and uniformity of equipment designs.

To give you long-life equipment, Pfaudler offers a complete range of corrosion-resistant materials. This includes stainless steel, Hastelloy, monel, nickel, inconel, aluminum, glassed steel, and others.

Cut your equipment costs, and get the advantages of unbiased selection of construction materials, with Pfaudler glassed steel and alloy columns.



NEW SYNTHETIC ADSORBENT comes in three forms: powdered (with high capacity) and two sizes in pelleted form

Thinking of Adsorption?

Here's a new synthetic adsorbent that provides a different approach to the use of this process

A Staff Report by the Editors of PETROLEUM PROCESSING

ADSORPTION—growing in use and interest as a separation technique in the petrochemical processing industry—got a further boost last month when a new adsorbent material developed by Union Carbide and Carbon Corp.'s Linde Air Products Co. division was announced.

Serving the same function as existing adsorbents like activated carbon or silica gel, but differing somewhat in basic approach, the material is tradenamed "Molecular Sieves," and it will separate liquid and gaseous materials on the basis of a difference in molecular size. It was reported on briefly a month ago and will be described here in further detail.

A synthetic adsorbent with high selectivity, the new material is said to offer a good future for wider application of adsorption to full-scale processing, making it competitive in certain respects with such other processes as distillation, solvent extraction, fractional crystallization, and other commercial techniques.

Possible applications include—both in process operations and in research:

1—Hydrocarbon separation; for example, straight-chain from cyclic and branched chain hydrocarbons.

2—Recovering unsaturates from waste gas streams; for example, ethylene, acetylene, propylene, and butene.

3—Gas purification; for example, removal of unwanted substances such as carbon monoxide and dioxide, ammonia, hydrogen sulfide, and mercaptans.

4—Drying liquids, such as ethylene glycol dimethyl ether, transformer oils, ethanol, toluene, benzene, pyridine, and others.

The same kind of a job can be done by certain naturally occurring materials—the zeolites, which are essentially silicates—but only a few of them are said to have the properties that would make them suitable for commercial adsorption.

Chemically, the new materials are synthetic zeolites, quite similar to many natural clays and feldspars. Structurally, however, they are different. And that is what provides them with the high selectivity, according to Linde.

The atoms of sodium, calcium, silicon, aluminum, and oxygen in the material (mainly in the form of sodium or calcium aluminum silicate) are arranged in a definite and consistent crystalline pattern. This structure contains a large number of small cavities, interconnected by a number of still smaller holes or pores. These cavities and the pores are very uniform in size. When the water of hydration is driven off, the crystalline structure retains its form and it is strong enough to be brought up to red heat without breaking down.

The empty cavities have a strong tendency to recapture the water molecules that were driven off during manufacture. Or, if no water is present, they will accept almost any material that can pass through the pore and into the cavity. And therein lies the secret of the material's ability at selective

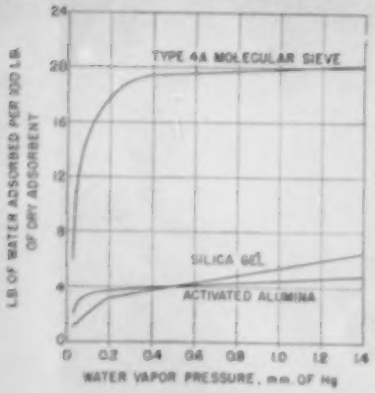

LB. OF WATER ADSORBED PER 100 LB. OF DRY ADSORBENT
TYPE 4A MOLECULAR SIEVE
SILICA GEL
ACTIVATED ALUMINA
WATER VAPOR PRESSURE, mm. OF Hg

FIG. 1—Water adsorption isotherms at 25° C.

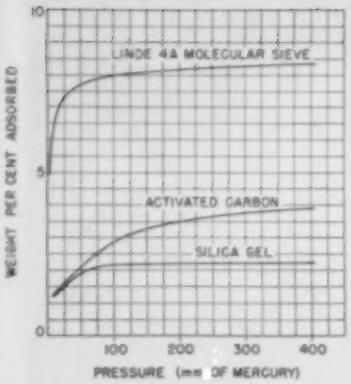


FIG. 2—Acetylene adsorption at 25° C.

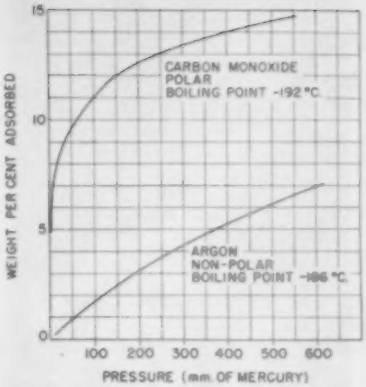


FIG. 3—Adsorption of carbon monoxide and argon on the Type 5A molecular sieve at —75° C.

hydrocarbon separation, for example.

A difference in diameter between straight-chain and branched-chain molecules is just enough to be the essential factor in whether such molecules can enter the pore (4 to 5 angstroms in diameter) and be caught, or not enter at all. Hence, the "sieve" action.

This is very helpful—say—on a mixture of compounds with different molecular weights but similar boiling points. The fact that boiling points are alike knocks out distillation as a possible separating technique.

Among other benefits for the molecular sieves cited by Linde are: they adsorb small molecules but not large ones. They are particularly good adsorbent for water and other polar materials, and for unsaturated hydrocarbons. They have high adsorption capacities at low adsorbate concentrations and at elevated temperatures. They can be used in many types of existing equipment and processes. They are easily reactivated and re-used. They can be sold at prices making their use economically feasible.

Linde has been working on this idea since the late 1940's and started a test-marketing program of the material in March, 1954. They have contacted almost 300 different petroleum, chemical, and pharmaceutical firms in the early stages of the market development program and report that about 85% of those contacted showed interest in the material and asked for samples to conduct their own studies. Though no names were disclosed, it was said that two plants have been using the molecular sieves for full-scale production purposes for well over a year.

Several tons of the product have been sold already for pilot-scale testing (at $1.95 per lb.), and Linde sees nothing but a downward trend in cost as usage expands and sales grow.

Two types of molecular sieves have been developed, differing only in the size of the pore. The first, with a pore opening of about 4 angstroms in diameter, can adsorb molecules smaller than about 4 ang. For example, ethane is adsorbed by this type, but propane is not.

The second has a slightly larger pore opening, about 5 ang. It adsorbs straight-chain hydrocarbons like normal hexane, but not branched-chain iso-hexanes nor cyclics like cyclohexane and benzene.

Molecular sieves adsorb only those molecules that are small enough to enter their pore system. Table 1 classifies the hydrocarbons and other chemical compounds which are adsorbed by each of the two types of sieves, the 5-ang. or Type 5A and 4-ang. or Type 4-A.

A comparison of the sieves with silica gel and activated carbon on such materials as normal and iso-butane; benzene; normal, sec., and iso-butyl

Table 1—Adsorption Comparison by Pore Size

Adsorbed on 5A and 4A	Adsorbed on 5A but not 4A	Not Adsorbed on Either 5A or 4A
Water	Propane and higher n-paraffins up to at least C_{10}	Iso-butane and all iso-paraffins
Carbon dioxide	Butene and higher n-olefins	Iso-propanol and all iso-, secondary, and tertiary alcohols
*Carbon monoxide	n-Butanol and the higher normal alcohols	Benzene and all aromatics
Hydrogen sulfide	Cyclopropane	Cyclohexane and all cyclics with at least 4-membered rings
Sulfur dioxide	Freon 12	Carbon tetrachloride
Ammonia		Hexachlorobutadiene
*Nitrogen		Freon 114
*Oxygen		Freon 11
*Methane		Sulfur hexafluoride
Methanol		Boron trifluoride
Ethane		Molecules larger than 5.0 angstroms
Ethanol		
Ethylene		
Acetylene		
Propylene		
n-Propanol		
Ethylene oxide		

*Appreciable quantities of these low boiling materials are adsorbed only at temperatures below —20° F.

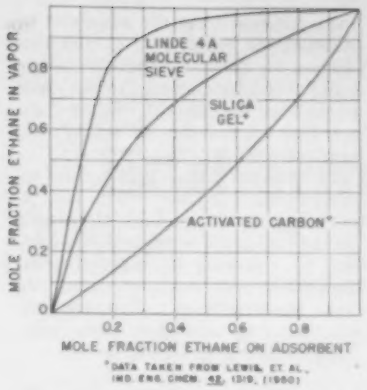

MOLE FRACTION ETHANE IN VAPOR
LINDE 4A MOLECULAR SIEVE
SILICA GEL*
ACTIVATED CARBON*
MOLE FRACTION ETHANE ON ADSORBENT
*DATA TAKEN FROM LEWIS, ET AL., IND. ENG. CHEM. 42, (12), (1950)

FIG. 4—Ethane-ethylene adsorption equilibrium at 25° C. temperature and 1 atmos. pressure

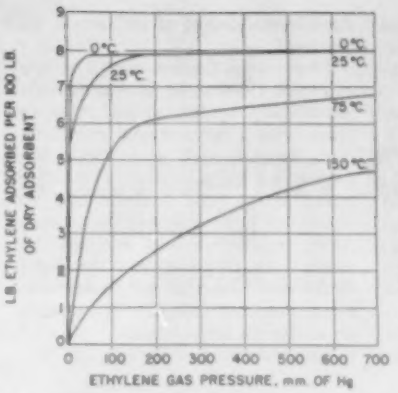


FIG. 5—Ethylene adsorption isotherms on Type 4A in pellet form

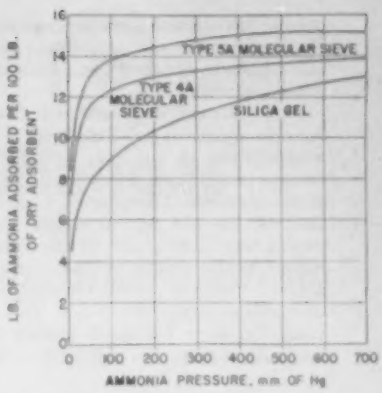

LB. OF AMMONIA ADSORBED PER 100 LB. OF DRY ADSORBENT
TYPE 5A MOLECULAR SIEVE
TYPE 4A MOLECULAR SIEVE
SILICA GEL
AMMONIA PRESSURE, mm. OF Hg

FIG. 6—Ammonia adsorption isotherms at 25° C.

alcohols is shown in Table 2. Another kind of comparison is shown in Table 3: adsorption of C_2 hydrocarbons by the sieves increases in going from the saturated ethane molecule through the unsaturated ethylene molecule to the highly unsaturated acetylene molecule. Conversely, activated carbon is shown to be a good adsorbent for ethane, but not for ethylene, and particularly not for acetylene. Silica gel adsorbs only small amounts of the three gases.

A useful property, in addition to the characteristic exemplified by the name given to the synthetic adsorbent—molecular sieves—is its capacity to adsorb relatively large quantities of a material that comprises only a small part of a mixture of gases or liquids.

For example, the 4-ang. material will adsorb 19% of its own weight in water from a gas that has a relative humidity of only 2%, approximately five to six times as much water as can be adsorbed by such materials as silica gel and activated alumina under similar conditions. Fig. 1 shows how this works on water, and Fig. 2 on acetylene.

Affinity for polar molecules and for unsaturated molecules are also properties adding to the potential usefulness of the new material. One example of the affinity for polar molecules is of course water. Others are hydrogen sulfide and carbon monoxide (see Fig. 3). The molecular sieves will adsorb polar in preference to non-polar molecules even though both are of the same size. This helps in the removal of polar materials from refinery and from synthesis gases, where such conditions obtain.

In the case of affinity for unsaturates, a separation of ethane from ethylene is a good example. If a mixture of the two gases flows into a column containing 4-ang. sieves, the ethylene would be adsorbed in preference to the ethane. Ethane could be collected at the outlet of the column, and a very ethylene-rich mixture could be reclaimed from the molecular sieves by heating. Fig. 4 shows the composition of ethane-ethylene gas phase and adsorbed phase mixtures that are in equilibrium with different adsorbents. The sieve material has a strong preference for ethylene as mentioned, and the activated carbon has a small preference for ethane.

Recovery of even small amounts of such materials as ethylene, acetylene, propylene, and butylene—0.5 to 10%—from gas streams is seen as an application for the new adsorbents. Figs. 5 and 6 illustrate adsorption isotherms for ethylene and ammonia.

Reactivation of the adsorbent is a relatively simple matter, Linde points out; it is handled by heating and purging. The same batch of sieves can be used over and over again in a cyclic process.

Hydrocarbon separation tests have been made in a number of different cases, among them the separation of

Table 2—Molecular Sieve Adsorption

Adsorbate	Temp. °C.	Pressure mm. Hg	Weight Per Cent Adsorbed — 5A Molecular Sieve	Silica Gel	Activated Carbon
n-Butane	25	47	9.8	3.4	24
iso-Butane	25	98	.5	4.8	26
Benzene	25	50	.5	35.0	44
n-butyl alcohol	25	2.0	12.6	27	39
sec.-butyl alcohol	25	3.0	1.4	21	21
iso-butyl alcohol	25	1.5	0.3	25	24

Table 3—Adsorption of C_2's at 25° C.

Adsorbent	Pressure	Weight % Adsorbed — C_2H_6	C_2H_4	C_2H_2
Type 4A Molecular Sieve	1 mm.	0.3	1.4	3.8
	100 mm.	3.8	7.8	7.7
Activated Carbon	100 mm.	5.9	4.8	3.5
Silica Gel	100 mm.	0.7	2.4	2.2

normal tetradecane from benzene and the purification of isopentane, normal dodecane, isosafrole, and other organic materials.

N-tetradecane was removed from benzene by passing the mixture (5% n-tetradecane in benzene) through a column packed with 5-ang. size pellets of the adsorbent. The column, 4 cm. in diameter by 134 cm. in length, was packed with 1161 grams of adsorbent. Before breakthrough of the n-tetradecane, 1965 gm. of 99.9% benzene were removed from the system. This is equivalent to an 8.8 wt.-% loading of n-tetradecane on the adsorbent. An equilibrium loading of 10.7 wt.-% was obtained.

Flow rate in the test was 12 cc./min. of liquid. Effluent liquid was analyzed periodically by measuring refractive index with a thermostated refractometer. Breakthrough and equilibrium capacity of the adsorbent were determined from these analyses and the amount of liquid entering the column. After equilibrium was reached, the column was drained and the liquid held in the adsorbent was removed by evacuation and collected by condensers at dry ice temperatures.

The adsorbed n-tetradecane was then removed from the adsorbent by steaming the bed at 250° C. and condensing the desorbed vapor. Refractive index measurements on the two components of the original mixture indicate that the materials recovered were approximately 99.9% pure.

In other test runs: n-heptane was removed from a mixture of 11.3 mol % of n-heptane in methylcyclohexane; commercial grade isopentane was purified by removing its n-hydrocarbon impurities; and unknown impurities were removed from n-dodecane and isosafrole. All operations were made using the 5-ang. molecular sieves.

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Latex Paints

Latex Paints, lineal descendants of whitewash as regards method of application, have in the past five years caused revolutionary changes in the painting industry. Introduced in 1949, these water-thinned paints are already used for 50% of interior-wall painting, and their advocates insist that even a larger share of the market is in sight. All this spells increased markets for petrochemicals, the basic materials for all the latex paints now used in any volume.

The generic term for these materials, "latex paints" (pronounced "lay-teks"), has by now largely supplanted the earlier title, "rubber-based paints." Both of these phrases owe their origin to the fact that, like the natural-rubber material as it comes from the tree ("latex"), the basic substance in these paints is an emulsion (water dispersion) of solidifiable particles which may be agglomerated by various means (coagulated into solids, or made to form solid films). Moreover, the chief (and first) latex paint is a styrene-butadiene copolymer closely related to GR-S synthetic rubber, but differing in the proportions of the two raw materials.

In addition to the styrene-butadiene copolymer, other latex paints are emulsions of polystyrene, polyvinyl acetate, vinyl - vinylidene chloride copolymers, and polyacrylics. All of these are derived from petrochemicals —styrene, butadiene, vinyl acetate, vinyl chloride, vinylidene chloride, etc.; many are derivatives of such basic building blocks as ethylene and acetylene, in turn prepared by pyrolysis, catalytic dehydrogenation, or partial oxidation of petroleum fractions and natural gas.

The latex paints also contain pigments, emulsifiers, foam suppressors, surfactants, preservatives, etc., and are sometimes modified with other ingredients. Their advantages are many, especially for the "do-it-yourself" worker—easy application with a roller, quick drying (dry to the touch in about an hour), short-lived and nonpenetrating odor, absence of fire hazard (being water thinned), ease of brush and roller cleaning, and high degree of scrubbability. Even professional contractors are being attracted by their speed of application, and long-standing prejudices against water-thinned paints like whitewash, casein emulsions, and alkyd-resin emulsions are now being dissipated by the outstanding properties of the new materials.

Nitric Acid

Nitric Acid, pronounced "**nye**-trick **ass**-id," is so basic an industrial chemical that its growing status as a petroleum (natural-gas) derivative has tended to be overlooked. Having the formula HNO_3 (one hydrogen, one nitrogen, and three oxygen atoms per molecule), it is a liquid which is available in various grades (colorless or yellow), most of which are characterized by their corrosive, fuming, suffocating properties. Heavier than water per unit volume, it freezes well below the corresponding temperature for the latter, and boils (with some decomposition) at a temperature slightly lower than that for water. Chemistry students rapidly become acquainted with the yellow stains it leaves on their skin.

Industrial uses of nitric acid are legion. It finds direct application in the pickling of stainless steel, and as an etching agent in photo-engraving. It is used as a nitrating agent in the synthesis of a wide variety of explosives, dyes, drugs, and plastics. It is a powerful oxidizing agent, finding use in the synthesis of manganese oxide, oxalic acid, terephthalic acid, and adipic acid.

Nitric acid has been produced commercially by "nitrogen fixation" from the nitrogen and oxygen of the air, and before and since then by the reaction of sulfuric acid on Chilean saltpeter. Today, however, it is most economically manufactured by the oxidation of ammonia. The latter is itself chiefly prepared from nitrogen and hydrogen, the hydrogen being the petroleum or natural gas-derived raw material. As detailed earlier in this series, hydrogen is prepared from natural gas by pyrolysis, partial oxidation, or reaction with steam, or may be obtained as a by-product from the catalytic reforming of naphtha.

Annual production of nitric acid via the now-dominant ammonia route continues to grow, and total domestic output may soon reach 2,000,000 tons a year. Most of this is used by its producers, indicating the importance of nitric acid as a key material in the manufacture of both organic and inorganic chemicals.

Predict hydrocarbon . . .

Isothermal Enthalpy Changes

. . . with Berthelot's equation of state

By JAMES H. WEBER
Dept. of Chemistry and Chemical Engineering
University of Nebraska

THE engineer, confronted with the problem of determining enthalpy changes for pure materials, has three methods at his disposal. He may:

Use thermodynamic data based on reliable experimental data and rigorous relationships.

Use generalized correlation charts, such as presented by Hougen and Watson[3] or Edmister[2].

Use an equation of state.

The first method should be used if possible. However, such data have been determined for a relatively few substances; so, this most accurate procedure cannot be used in many instances.

In such cases the engineer usually resorts to the use of a generalized chart. The main reasons for this are simplicity and a fair degree of accuracy.

In this paper it will be shown Berthelot's equation of state can be used to predict enthalpy changes of pure substances with a good degree of accuracy up to pressures of 300 to 400 psia. The results obtained through the use of this equation of state are of comparable accuracy to those calculated from the generalized chart.

The Berthelot equation was first published in 1897 and is:

$$P = \frac{RT}{V-b} - \frac{a}{TV^2} \qquad (1)$$

where a and b are constants. The original values of these constants were:

$$a = \frac{27R^2T_c^3}{64P_c}$$

$$b = \frac{RT_c}{8P_c}.$$

Later developments indicated, however, that the equation of state correlates the data better when b is set equal to $9RT_c/128P_c$. The values for a and b may be substituted in the equation with the result:

$$PV = RT\left[1 + \frac{9P_r}{128\,T_r}\left(1 - \frac{6}{T_r^2}\right)\right]$$

It will be noted that this form of the equation is explicit in V. The expression for the change in enthalpy with pressure under isothermal conditions is:

$$\frac{(\delta H)}{(\delta P)_T} = -\left[V - T\frac{(\delta V)}{(\delta P)_T}\right]$$

The Berthelot equation can be substituted into this relationship and a direct solution obtained. The result of this substitution is:

$$M(Hp - H^\circ)_T = \frac{9RT_cP_r}{128}\left(1 - \frac{18}{T_r^2}\right) \qquad (2)$$

To use this expression requires only knowledge of the critical temperature and pressure, as is the case for the generalized property charts.

To show the accuracy of the Berthelot equation of state, changes in enthalpy under isothermal conditions have been calculated by the equation for representative compounds of the paraffinic, olefinic, and aromatic groups. Methane and n-butane were the paraffins selected, ethylene the olefin, and benzene the aromatic compound.

The values calculated using Equation 2 were then compared with data for the respective compounds published in the literature.[4, 5, 6, 7] Tables 2 through 5 present these results. Also in the tables are shown a few representative values for enthalpy changes obtained from the generalized chart of Hougen and Watson[3].

It will be noted that, in many instances, the results obtained from the Berthelot equation are more accurate than those obtained by the use of the generalized charts. At higher pressures than those reported in the tables, the generalized charts would, undoubtedly, produce results better than the equation of state.

Non-isothermal enthalpy changes can be predicted by using the Berthelot equation in conjunction with the data given in API 44[1].

For example, assume it is desired to determine the enthalpy change for n-butane when it goes from a temperature of 200° F. and a pressure of 29.4 psia to 260° F. and a pressure of 147 psia. One can obtain the enthalpy changes from 29.4 to 0 psia pressure at 200° F. and from 0 to 147 psia pressure at 260° F. by Equation 2. The enthalpy change from 200° to 260° F. under zero pressure may be obtained from data given in API 44[1]. The solution to this problem is shown

Meet the Author

James H. Weber, associate professor of chemical engineering at the University of Nebraska, received chemical engineering education at the University of Pittsburgh (B.S. 1941, M.S. 1947, Ph.D. 1948). He belongs to the American Chemical Society, American Society of Engineering Education, Sigma Xi, and American Institute of Chemical Engineers. He is engaged in consulting work, and spends summers working for an oil company.

in Table 1, giving an enthalpy change of 22.0 Btu./lb. This compares to a value of 21.7 Btu./lb. obtained from the data of Prengle, Greenhaus, and York[6].

In summation, it has been demonstrated that the Berthelot equation may be used to predict enthalpy changes with pressure under isothermal conditions for a number of hydrocarbons, up to pressures of 400 psia and under moderate temperature conditions. The results obtained by the Berthelot equation compare very favorably with those predicted by the generalized chart of Hougen and Watson.

More precise results could be achieved by the use of a more complicated equation of state, such as the Benedict-Rubin-Webb equation. But an equation of this type is too complex for the engineer to use in routine calculations.

While it is not recommended that the Berthelot equation be used to predict isothermal enthalpy changes for methane, n-butane, ethylene, and benzene, the comparisons presented illustrate the degree of accuracy that may be expected when this equation is used under similar circumstances for related substances.

Nomenclature

H = enthalpy, Btu./lb.
M = molecular weight
P = pressure, psia
R = gas law constant, 10.72 psia-ft³/lb-mole °R or 1.98 Btu/lb-mole °R
T = absolute temperature, °R
V = molal volume, ft³ per lb-mole
a = constant of Berthelot equation
b = constant of Berthelot equation
t = temperature, °F

Subscripts

c refers to critical property
r refers to reduced property

Superscripts

o refers to property in the ideal gas state at unit fugacity (14.7 psi)

References

(1) Rossini, F. D., et al., "Selected Values of Properties of Hydrocarbons," Nat'l. Bur. Standards Circ. c 461 (1948) American Petroleum Institute Research Project 44.
(2) Edmister, W. C., *Petroleum Refiner*, 28, No. 2 137-48 (1949)
(3) Hougen, O. A. and Watson, K. M., "Chemical Process Principles," Part IV, John Wiley and Sons, Inc., New York (1947)
(4) Matthews, C. S., and Hurd, C. O., *Trans. A. I. Ch. E.*, 42, 55 (1946)
(5) Organick, E. I., and Studhalter, W. R., *Chem. Eng. Prog.*, 44, 847 (1948)
(6) Prengle, H. W. Jr., Greenhaus, L. R., and York, R. Jr., *Chem. Eng. Prog.*, 44, 863 (1948)
(7) York, R. Jr., and White, E. F. Jr., *Trans. A. I. Ch. E.*, 40, 227 (1944)

Table 1—Non-isothermal enthalpy changes calculated by Berthelot's equation of state

ΔH	0 psia 29.4 psia	at 200° F.	+2.2 Btu/lb. (Equation 2)
ΔH	260° F. 200° F.	at 0 psia	+29.3 Btu/lb. (API 44[3])
ΔH	147 psia 29.4 psia	at 260° F.	−9.5 Btu/lb. (Equation 2)
ΔH	147 psia 29.4 psia	at 260° F. at 200° F.	+22.0 Btu/lb. net enthalpy change

Table 2—N-Butane: Isothermal enthalpy changes

	Temperature °F							
	200	260	300	360	400	460	500	540
ΔH (0 to 9 atm.)								
Observed[5]	−2.1	−1.8	−1.7	−1.4	−1.3	−1.2	−1.1	−1.0
Berthelot	**−2.2**	**−1.9**	**−1.6**	**−1.4**	**−1.3**	**−1.1**	**−1.0**	**−0.8**
Gen. Chart[3]	−2.8	—	—	−1.5	—	—	—	—
ΔH (3 to 6 atm.)								
Observed[5]	−4.4	−3.7	−3.4	−2.8	−2.6	−2.2	−2.1	−1.9
Berthelot	**−4.6**	**−3.8**	**−3.3**	**−3.0**	**−2.7**	**−2.2**	**−1.9**	**−1.8**
Gen. Chart[3]	−5.9	—	—	−3.1	—	—	—	−2.0
ΔH (3 to 9 atm.)								
Observed[5]	−6.7	−5.6	−5.0	−4.3	−3.9	−3.4	−3.1	−2.9
Berthelot	**−6.8**	**−5.7**	**−4.9**	**−4.4**	**−3.8**	**−3.3**	**−3.0**	**−2.7**
Gen. Chart[3]	−9.1	—	—	−4.4	—	—	—	−3.0
ΔH (10 to 6 atm.)								
Observed[5]	−12.3	−9.8	−8.6	−7.2	−6.5	−5.6	−5.2	−4.8
Berthelot	**−11.4**	**−9.5**	**−8.0**	**−7.3**	**−6.5**	**−5.6**	**−5.1**	**−4.8**
Gen. Chart[3]	−16.6	—	—	−7.5	—	—	—	−4.9
ΔH (10 to 9 atm.)								
Observed[5]	—	−23.7	−19.4	−15.1	−13.4	−11.6	−10.6	−9.8
Berthelot	—	**−10.4**	**−16.5**	**−15.0**	**−13.3**	**−11.5**	**−10.3**	**−9.6**
Gen. Chart[3]	—	−28.9	—	−16.3	—	—	—	−10.3
ΔH (15 to 9 atm.)								
Observed[5]	—	—	−25.8	−19.8	−17.4	−14.8	−13.6	−12.4
Berthelot	—	—	**−20.0**	**−18.2**	**−16.2**	**−14.0**	**−12.6**	**−11.6**
Gen. Chart[3]	—	—	—	−26.3	—	—	—	−12.9

Table 3—Benzene: Isothermal enthalpy changes

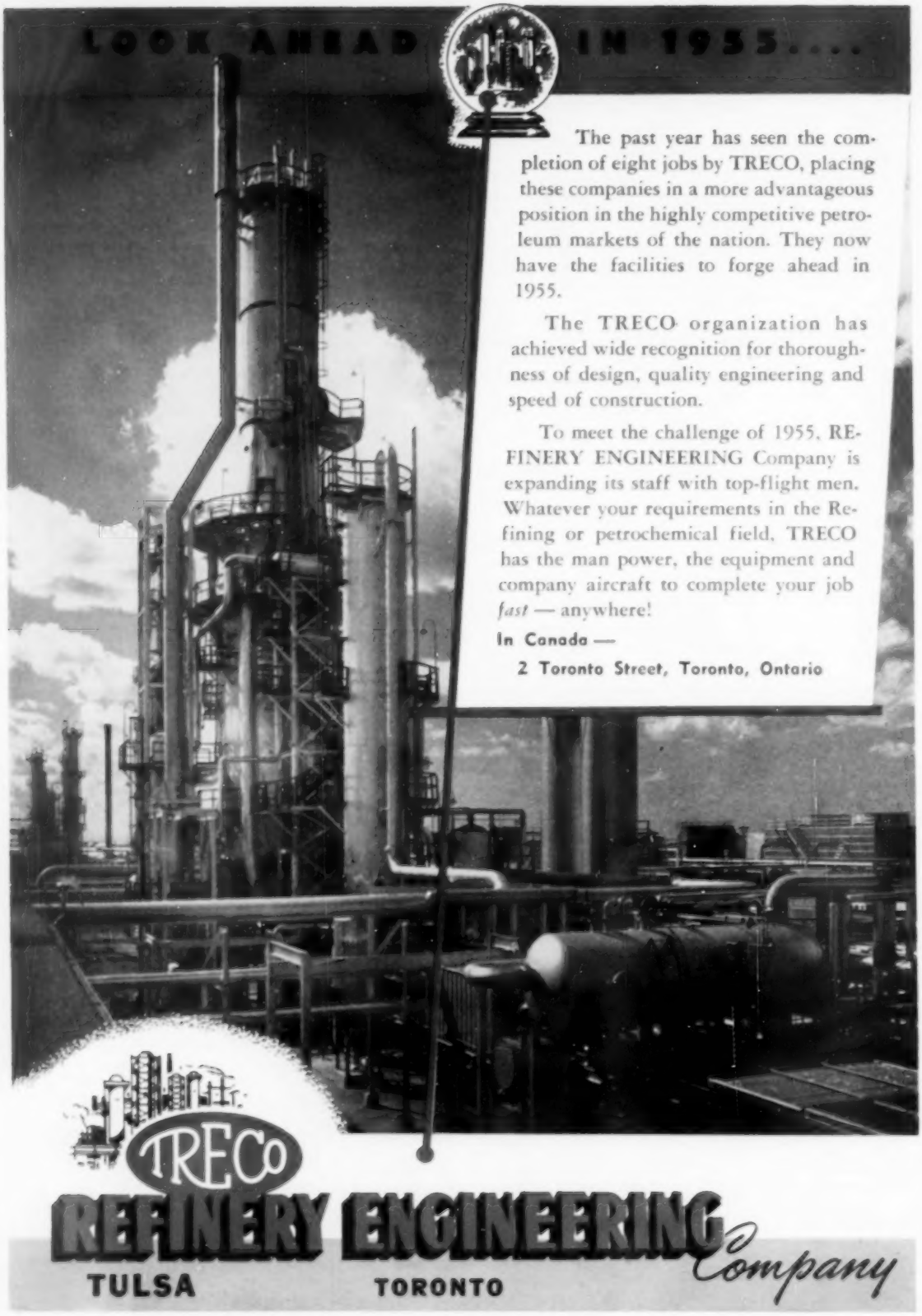
	Temperature °F								
	400	500	600	800	1000	1200	1400	1600	1800
ΔH (100 to 14.7 psia)									
Observed[5]	−6.5	−4.6	−3.5	−2.2	−1.5	−1.1	−0.9	−0.7	−0.5
Berthelot	**−5.2**	**−4.1**	**−3.3**	**−2.3**	**−1.6**	**−1.3**	**−0.9**	**−0.7**	**−0.6**
Gen. Chart[3]	−7.4	−5.7	−5.4	−2.5	−1.9	−1.6	—	−1.4	—
ΔH (200 to 14.7 psia)									
Observed[5]	−15.6	−10.6	−7.9	−4.8	−3.5	−2.4	−1.9	−1.4	−1.1
Berthelot	**−11.3**	**−9.0**	**−7.2**	**−5.0**	**−3.6**	**−2.7**	**−2.0**	**−1.6**	**−1.2**
Gen. Chart[3]	−18.9	−11.2	−8.9	−5.5	−4.1	−3.7	−2.6	−2.2	−1.9
ΔH (300 to 14.7 psia)									
Observed[5]	—	−17.4	−12.6	−7.5	−5.1	−3.7	−2.8	−2.2	−1.7
Berthelot	—	**−13.8**	**−11.2**	**−7.7**	**−5.6**	**−4.2**	**−3.1**	**−2.7**	**−1.9**
Gen. Chart[3]	—	—	—	−8.5	—	−5.6	—	—	−2.8
ΔH (400 to 14.7 psia)									
Observed[5]	—	−25.9	−17.8	−10.4	−6.9	−5.0	−3.8	−2.9	−2.3
Berthelot	—	**−19.0**	**−15.3**	**−10.6**	**−7.6**	**−5.7**	**−4.3**	**−3.4**	**−2.6**
Gen. Chart[3]	—	—	—	−13.5	—	−6.7	—	—	−3.7

Table 4—Methane: Isothermal enthalpy changes

	Temperature °F											
	−220	−200	−150	−100	−50	0	50	100	200	300	400	500
ΔH (15 to 15 psia)												
Observed[4]	−1.2	−1.1	−0.8	−0.6	−0.5	−0.4	−0.3	—	—	—	—	—
Berthelot	**−1.6**	**−1.4**	**−1.0**	**−0.7**	**−0.5**	**−0.4**	**−0.3**	—	—	—	—	—
Gen. Chart[3]	−4.2	−3.2	−1.2	—	—	—	—	—	—	—	—	—
ΔH (50 to 15 psia)												
Observed[4]	−4.5	−3.9	−2.9	−2.2	−1.8	−1.4	−1.2	−0.9	−0.7	−0.6	−0.4	−0.3
Berthelot	**−5.6**	**−4.8**	**−3.3**	**−2.4**	**−1.8**	**−1.4**	**−1.1**	**−0.9**	**−0.6**	**−0.4**	**−0.3**	**−0.2**
Gen. Chart[3]	−12.4	−8.5	−4.1	−2.5	−2.0	−1.6	—	—	—	—	—	—
ΔH (100 to 15 psia)												
Observed[4]	—	−10.2	−7.3	−5.5	−4.3	−3.3	−2.8	−2.3	−1.8	−1.5	−1.2	−0.9
Berthelot	—	**−11.6**	**−8.0**	**−5.9**	**−4.4**	**−3.4**	**−2.7**	**−2.2**	**−1.4**	**−1.0**	**−0.7**	**−0.5**
Gen. Chart[3]	—	−20.7	—	—	—	−3.7	—	−2.7	−2.0	—	—	—
ΔH (150 to 15 psia)												
Observed[4]	—	—	−11.8	−8.8	−6.9	−5.5	−4.5	−3.7	−2.8	−2.0	−1.5	−1.3
Berthelot	—	—	**−12.7**	**−9.3**	**−7.0**	**−5.4**	**−4.3**	**−3.5**	**−2.3**	**−1.6**	**−1.2**	**−0.8**
Gen. Chart[3]	—	—	−17.0	—	—	−6.3	—	−4.3	−3.2	−2.5	−2.2	—
ΔH (200 to 15 psia)												
Observed[4]	—	—	−16.9	−10.5	−9.6	−7.6	−6.1	−5.1	−3.8	−2.8	−2.3	−1.9
Berthelot	—	—	**−17.4**	**−12.7**	**−9.6**	**−7.5**	**−5.9**	**−4.7**	**−3.2**	**−2.3**	**−1.6**	**−1.1**
Gen. Chart[3]	—	—	−23.9	—	—	−8.3	—	−5.7	—	—	−2.7	—
ΔH (300 to 15 psia)												
Observed[4]	—	—	−28.5	−19.8	−15.3	−12.0	−9.3	−7.8	−5.8	−4.5	−3.6	−3.0
Berthelot	—	—	**−26.8**	**−19.6**	**−14.8**	**−11.5**	**−9.1**	**−7.3**	**−4.9**	**−3.4**	**−2.4**	**−1.6**
Gen. Chart[3]	—	—	−41.5	—	—	−13.1	—	−8.8	—	—	−4.0	−3.8
ΔH (500 to 15 psia)												
Observed[4]	—	—	—	−28.0	−21.2	−16.4	−12.9	−11.5	−7.8	−5.8	−4.6	−3.7
Berthelot	—	—	—	**−26.8**	**−20.0**	**−15.8**	**−12.3**	**−9.4**	**−6.6**	**−4.6**	**−3.2**	**−2.2**
Gen. Chart[3]	—	—	—	—	—	−17.7	—	−10.3	—	—	−5.6	−4.8

Table 5—Ethylene: Isothermal enthalpy changes

	Temperature °F											
	−60	0	40	60	100	140	200	240	300	340	400	440	500
ΔH (1 to 1 atm)													
Observed[7]	−3.7	−3.2	−2.6	−2.4	−2.0	−1.7	−1.4	−1.2	−1.0	−0.9	−0.8	−0.7	−0.6
Berthelot	**−4.3**	**−3.1**	**−2.7**	**−2.5**	**−2.1**	**−1.8**	**−1.5**	**−1.3**	**−1.0**	**−1.0**	**−0.8**	**−0.8**	**−0.6**
Gen. Chart[3]	−6.9	—	−2.8	—	—	−2.0	—	−1.5	—	—	—	—	—
ΔH (5 to 1 atm)													
Observed[7]	−7.8	−5.4	−4.4	−4.0	−3.3	−2.9	−2.4	−2.1	−1.7	−1.6	−1.4	−1.2	−1.1
Berthelot	**−7.1**	**−5.3**	**−4.4**	**−4.1**	**−3.5**	**−3.0**	**−2.4**	**−2.2**	**−1.7**	**−1.6**	**−1.3**	**−1.3**	**−1.0**
Gen. Chart[3]	—	—	—	—	—	—	—	—	—	—	—	—	—
ΔH (10 to 1 atm)													
Observed[7]	−9.2	−7.6	−6.2	−5.6	−4.7	−4.0	−3.3	−2.9	−2.4	−2.2	−1.9	−1.7	−1.5
Berthelot	**−10.0**	**−7.4**	**−6.2**	**−5.8**	**−4.9**	**−4.2**	**−3.4**	**−3.0**	**−2.5**	**−2.2**	**−1.8**	**−1.7**	**−1.4**
Gen. Chart[3]	−15.9	—	−6.3	—	—	−4.5	—	−3.5	—	—	−2.4	—	—
ΔH (15 to 1 atm)													
Observed[7]	−14.5	−10.0	−8.0	−7.3	−6.1	−5.2	−4.2	−3.7	−3.1	−2.8	−2.4	−2.2	−2.0
Berthelot	**−12.8**	**−9.5**	**−8.0**	**−7.4**	**−6.2**	**−5.4**	**−4.4**	**−3.9**	**−3.2**	**−2.9**	**−2.9**	**−2.2**	**−1.8**
Gen. Chart[3]	−23.1	−13.4	−9.4	—	—	−6.5	—	−4.9	—	—	−3.4	—	—
ΔH (25 to 1 atm)													
Observed[7]	—	−16.7	−12.9	−11.5	−9.6	−8.2	−6.6	−5.8	−4.9	−4.4	−3.9	−3.4	−3.0
Berthelot	—	**−14.8**	**−12.4**	**−11.4**	**−9.8**	**−8.4**	**−6.8**	**−6.0**	**−4.9**	**−4.4**	**−3.7**	**−3.4**	**−2.9**
Gen. Chart[3]	—	—	−13.3	—	—	−9.0	—	−6.9	—	—	−4.7	—	—
ΔH (35 to 1 atm)													
Observed[7]	—	−24.1	−18.3	−16.4	−13.3	−11.4	−9.1	−7.9	−6.7	−6.0	−5.2	−4.7	−4.1
Berthelot	—	**−21.1**	**−16.9**	**−15.8**	**−13.3**	**−11.4**	**−9.3**	**−8.2**	**−6.7**	**−6.0**	**−5.0**	**−4.6**	**−3.9**
Gen. Chart[3]	—	−32.0	−20.4	—	—	−13.3	—	−9.8	—	—	−6.7	—	—
ΔH (51 to 1 atm)													
Observed[7]	—	−32.7	−24.1	−21.3	−17.3	−14.5	−11.6	−10.2	−8.5	−7.6	−6.5	−5.9	−5.2
Berthelot	—	**−25.4**	**−21.3**	**−19.6**	**−16.7**	**−14.4**	**−11.7**	**−10.3**	**−8.6**	**−7.6**	**−6.4**	**−5.8**	**−4.9**
Gen. Chart[3]	—	—	−25.1	—	—	−16.3	—	−11.7	—	—	−6.3	—	—


LOOK AHEAD IN 1955....
The past year has seen the completion of eight jobs by TRECO, placing these companies in a more advantageous position in the highly competitive petroleum markets of the nation. They now have the facilities to forge ahead in 1955.
The TRECO organization has achieved wide recognition for thoroughness of design, quality engineering and speed of construction.
To meet the challenge of 1955, REFINERY ENGINEERING Company is expanding its staff with top-flight men. Whatever your requirements in the Refining or petrochemical field, TRECO has the man power, the equipment and company aircraft to complete your job *fast* — anywhere!
In Canada —
2 Toronto Street, Toronto, Ontario
TRECO
REFINERY ENGINEERING Company
TULSA
TORONTO

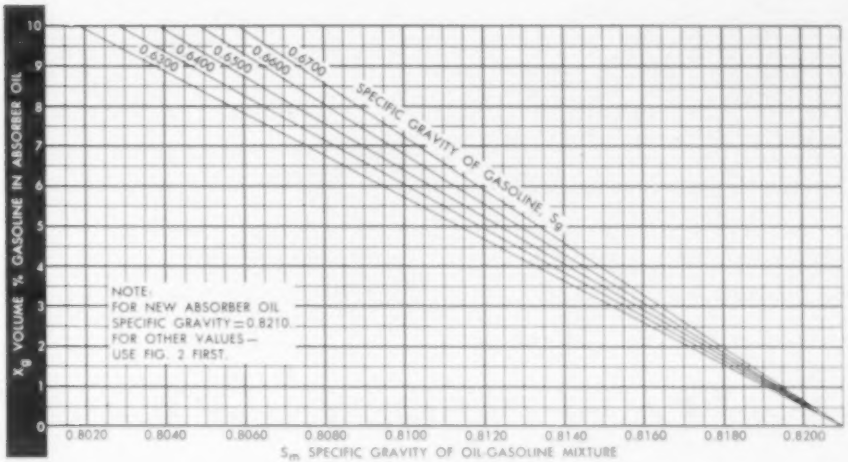


FIG. 1—Gasoline content of absorber oil

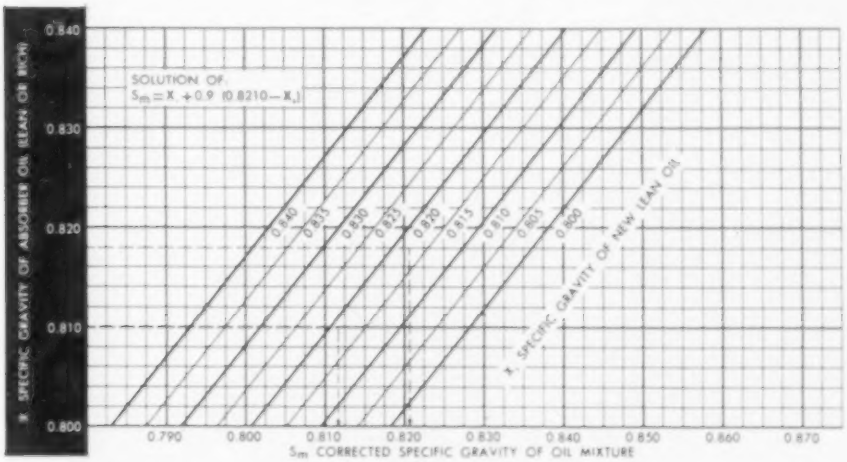


FIG. 2—Correction of absorber oil gravity to 0.8210

Gasoline Content Spot-Check

By THOMAS GARCIA B.
Petroleos Mexicanos*

SPOT-CHECKS of gasoline stripper operation in plants absorbing gasoline from natural gas are often needed more rapidly than is possible by ASTM Standard Method D-285-52.

Here is a graphical presentation that can give plant operators rapid approximations for the gasoline content of absorber oil to aid in plant operations.

Fig. 1 presents per cent gasoline in absorber oil versus gasoline and absorber oil specific gravities. The basis is the perfect-solution relationship:

$$1/S_m = W_a/S_a + W_b/S_b + W_c/S_c + \ldots$$

where:

S_m = Specific gravity of mixture
$S_a, S_b, S_c, \ldots$ = Specific gravities of mixture components $a, b, c, \ldots$
$W_a, W_b, W_c, \ldots$ = Weight fraction in mixture of components $a, b, c, \ldots$

Thus, for a two-component system consisting of absorber oil and absorbed gasoline:

$$S_m = S_o S_g / [S_o(W_g) + S_g(W_o)]$$

where:

$$W_g = S_g X_g / [S_o(X_o) + S_g(X_g)]$$
$$W_o = 1 - W_g$$

and:

X_g, X_o = Volume fraction of gasoline and absorber oil in mixture

The above relationship is calculated and plotted in Fig. 1

* Mr. Garcia B. is chief chemist, Laboratories TUGN, Petroleos Mexicanos, Poza Rica, Ver. Mexico, and a welcome new contributor to this department.

for a fixed absorber oil specific gravity of 0.8210 and for gasoline specific gravities of 0.6300, 0.6400, 0.6500, 0.6600, and 0.6700.

When new absorber oil does not have a specific gravity of 0.8210, a correction factor is needed before using Fig. 1. The correction is empirically represented by:

$$S_o(corrected) = X_1 + 0.9(0.8210 - X_2)$$

where:

X_1 = Specific gravity of absorber oil (lean or rich)

X_2 = Specific gravity of new (unused) absorber oil.

Fig. 2 presents a graphical solution for the gravity correction equation.

An example of the use of Figs. 1 and 2 is as follows:

A natural gasoline plant is using new absorber oil with 0.8190 specific gravity at 60/60° F. The specific gravity of the gasoline is 0.6400, of the absorber rich oil is 0.8100, and of the absorber lean oil is 0.8189. Determine the gasoline content of the rich and lean oils.

From Fig. 2, the corrected specific gravities for the rich and lean oils are determined:

Rich Oil, S_o(corrected) = 0.8118

Lean Oil, S_o(corrected) = 0.8207

From Fig. 1, the volume per cent gasoline contents are read directly:

Gasoline in Rich Oil = 5.06 vol.-%

Gasoline in Lean Oil = 0.12 vol.-%

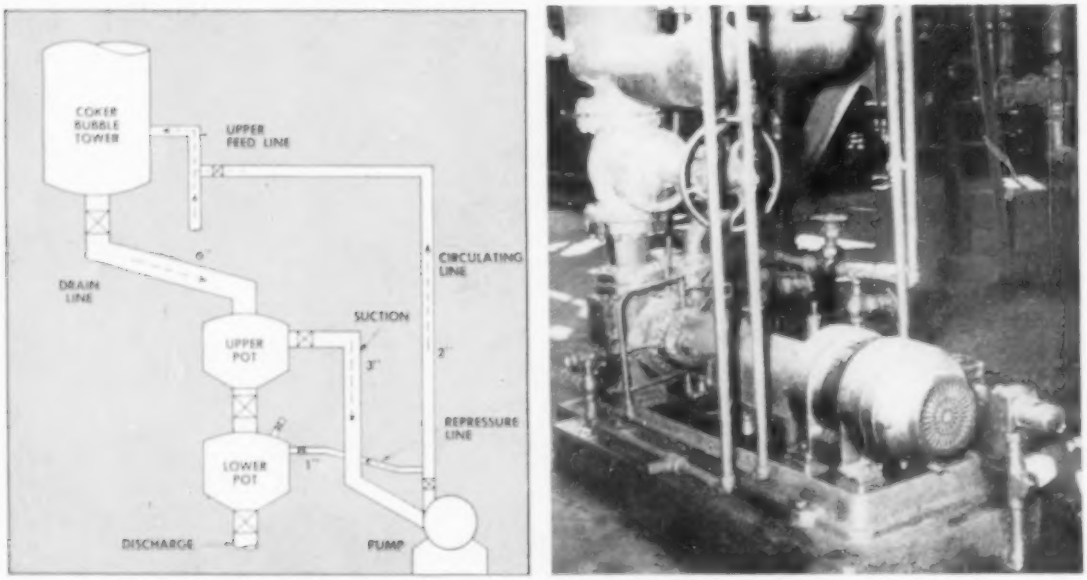
Comparison of the above to an actual ASTM gasoline content test at 175° C. gives:

Gasoline in Rich Oil = 3.0 vol.-%

Gasoline in Lean Oil = 0.10 vol.-%

While the preceding graphical method cannot give exact values for the gasoline content of absorber oil, it does enable the plant operator to obtain rapid approximate values to aid in operating the absorber and stripper sections of the plant.

How to Extend Coker Bubble Tower Runs



BOTTLENECK ELIMINATOR is this pair of coke settling pots shown in schematic diagram at left; photo at right shows the recirculating pump

COKE fines build-up in the coker bubble tower at General Petroleum Corp.'s Torrance, Calif., refinery had been a "bottle-neck" for the entire unit.

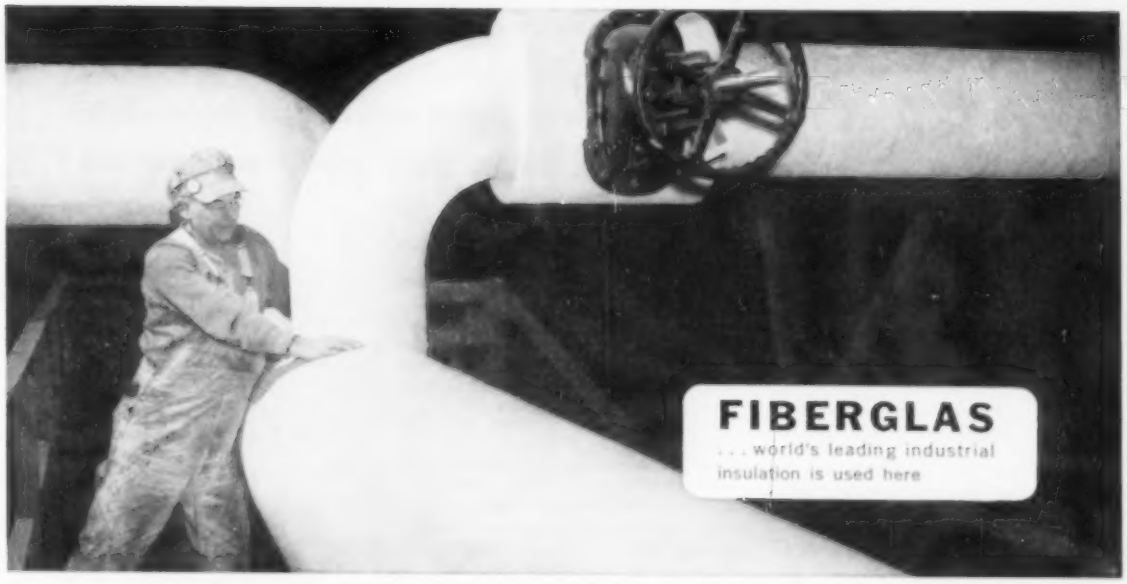
This tower was the only piece of equipment in the unit which could not be by-passed for cleaning while the unit was on-stream. Consequently coke fines were trapped in the tower until they reached the top of the outlet screen on the furnace charge pump line, causing the pumps to lose suction. Operations were subject to frequent shut-downs in order to clean accumulated fines out of the bubble tower.

The solution, illustrated in the drawing above, consists of two conventional settling or drop-out pots on the bottom of the tower, and an auxiliary circulating pump operating independently from the main bubble tower pumps.

Coke fines and some oil enter the drop-out pots, allowing the coke fines to settle. To keep the 6-in. drain line from the tower clear, the recirculating pump takes suction from the top of the upper drop-out pot and discharges oil into the upper feed line of the tower. This pump also repressures the lower drop-out pot after draining settled fines and excess oil.

A block valve on the line connecting the pots to the tower allows the pots to be taken out of service for cleaning. The pots can be isolated from each other also, thus allowing one pot to cool before it is drained of excess oil and coke fines.

This system has been in service for some time, and has extended the tower life and on-stream time. In addition to the increased operating time, removal of coke fines has decreased pump maintenance.



THEY ANSWER ALL YOUR INSULATION NEEDS!

Kaylo and Fiberglas* are outstanding in thermal efficiency. They offer the most complete and versatile line of plant insulations available, ranging from lowest sub-zero to 1200° F. They are exceptionally strong—moisture-resistant—dimensionally stable—light in weight and easy to apply. They can even be used again after removal for pipe inspection! (Kaylo is now distributed by Owens-Corning and is available in quantity.) For full technical data about Kaylo and Fiberglas insulations see Sweet's File, Chemical Engineering Catalog or Refinery Catalog. Or write: Owens-Corning Fiberglas Corporation, Dept. 185-A, Toledo 1, Ohio.

OWENS-CORNING
FIBERGLAS

*T. M. Reg. U.S. Owens-Corning Fiberglas Corporation

 (To obtain more data on advertised products see page 108)

Du Pont's new polymeric additives help prevent engine sludge under low-duty driving conditions

Which of these two new lube oil additives will do most to help sell your motor oil?

If you are looking for an outstanding sales theme to help expand your motor oil market, here are two entirely *new type* Du Pont lube oil additives that offer just such an opportunity.

Both are *polymeric* additives that provide an economical and effective means of preventing engine oil sludge . . . particularly under low-temperature, low-power, stop-and-go driving conditions. Both do double duty as detergents and V. I. improvers.

As such, they can add important sales appeal to your products in the mass passenger car field as well as in taxi and other urban fleet markets.

With either of them, in multigrade oil formulations, you supply not only superior low-duty detergency, but also *provide a substantial part* of the viscosity index improvement required.

Usually such formulations produce better performing oils at lower cost than can be obtained through other additives or methods.

DU PONT LUBE OIL ADDITIVE 564 is a new type polymeric additive which, because of its relatively low molecular weight, provides your oil with excellent shear stability in engine operation.

DU PONT LUBE OIL ADDITIVE 565 has a higher molecular weight than Lube Oil Additive 564 for greater viscosity index improvement.

Form No Sludge

These ashless polymeric lube oil additives permit more efficient operation of the engine oil system. Oil screens, rings, pistons, filters and other engine parts are kept clean and free from sludge. The resulting free flow of oil throughout the entire engine system keeps it in better operating condition for longer periods of time.

Commercial quantities of both additives are now available. For testing their effectiveness in your own motor oils, any of our regional offices listed below will be glad to supply you with samples.

DU PONT
Reg. U.S. Pat. Off.
Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

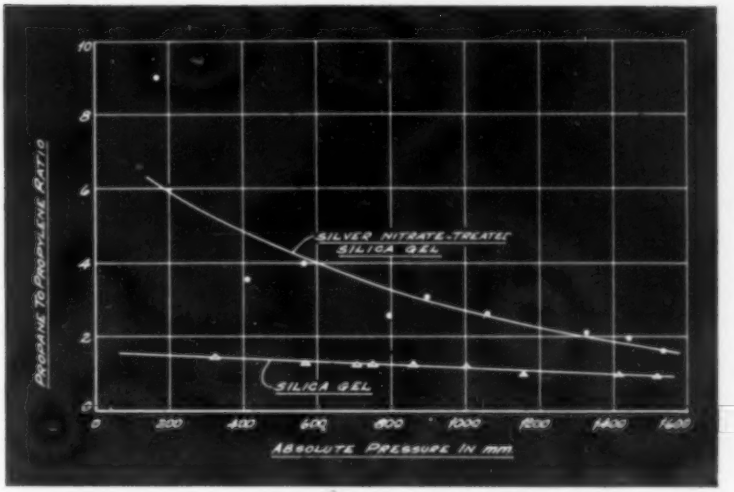
E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

Regional Offices:
NEW YORK, N. Y.—1270 Ave. of the Americas . . . Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—1811 So. Baltimore Ave. . . . . Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . . Phone BLackstone 1151
LOS ANGELES, CALIF.—612 So. Flower St. . . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond St. W., Toronto 1, Ont.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Building, 6539 Wilmington 98, Delaware

(To obtain more data on advertised products see page 108)

By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.



TREATED SILICA GEL can separate propylene from propane more effectively than untreated silica gel

Treated Adsorbent More Selective For Propylene-Propane Admixture

IT IS, of course, a well-known procedure to employ adsorbents such as silica gel for separating compounds from admixtures. However, some treated adsorbents may be more specific for certain classes of compounds. For example, The Texas Co. patent, No. 2,685,607, discloses the use of silver nitrate-treated silica gel for selectively separating olefins from other admixed hydrocarbons.

The illustration shows a comparison of results obtained in separating propylene from admixture with propane by such means. The charge stock in this case was composed of propane and propylene in the ratio of 0.86. This was passed at various pressures and at room temperature through a bed of silica gel impregnated with silver nitrate. The silica gel was a commercial grade material calcined at 600° F. for three hours prior to the test. It was then mixed with a solution containing 200 gms. of silver nitrate (per 800 gms. of gel), and the mixture was dried on a steam bath, then calcined at 500° F. for six hours.

It will be seen in the chart that at all pressures the selectivity of the silver nitrate impregnated silica gel is superior to that of untreated gel and that the selectivity of the impregnated gel increases markedly as the pressure is reduced. Thus, for example, in operating at atmospheric pressure with the silver nitrate-impregnated silica gel, the propane to propylene ratio is about 3.5 while the ratio with the untreated calcined silica gel is only 1.3.

Patent Gives Method for Making Jet Engine Fuel

IN U. S. patent No. 2,628,189, Tide Water Associated Oil Co. claims a method of preparing a liquid hydrocarbon composition adaptable for use as a fuel for gas turbines and jet engines. It is prepared with wide cut distillate fractions from a petroleum crude without need of repressurizing agents. The first step involves distilling a petroleum crude to obtain a light liquid hydrocarbon distillate fraction substantially devoid of butanes and compounds with boiling rates lower than butanes. The fraction has the following inspection:

Reid vapor pressure	5-12 psi
90% Evaporated at not over	350° F.
Final boiling point not over	600° F.
Distillation loss not over	2%

Also, there is obtained an intermediate liquid hydrocarbon distillate fraction comprised predominantly of constituents boiling within a range of 325°-390° F. This cut has a Reid vapor pressure of about 0 psi., and is 90% evaporated below 400° F.

Finally, a heavy liquid hydrocarbon fraction comes off with these properties:

Reid vapor pressure about	0 psi
Final boiling point not over	600° F.
Distillation loss less than	1.5%
Boiling above 400° F., at least	50%

The light fraction is combined with the heavy fraction in a volume ratio of 1 part heavy to 1-9 parts light to provide a liquid hydrocarbon composition having a Reid vapor pressure of 5-7 psi., distillation loss not over 1.5% by volume, and a 90% evaporated point at over 400° F. The latter fraction is the jet fuel and requires no repressurizing agents, so it is claimed by the patent.

Patents Issued in November

The following classified listing gives the patents number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U.S. Patent Office for November 2, 9, 16, 23, and 30, 1954, Vol. 688, Nos. 1-5.

PROCESSES

Refining

2,693,443 (Standard Oil Development Co.) Treatment of free-sulfur-containing liquefied petroleum gas with alkali metal hydroxide containing mercaptan.

2,693,463 (The Texas Co.) Separation of urea-type complexes from reaction mixtures.

2,693,495 (Standard Oil Development Co.) Recovery of pure hydrocarbons (aromatic separated from non-aromatic, using silica gel).

2,693,490 (Phillips Petroleum Co.) Selective removal of acetylene from ethylene-containing gases with chromium oxide-calcium nickel phosphate.

2,693,865 (Standard Oil Development Co.) Fractionation of hydrocarbon gases by solid adsorbents.

2,693,948 (Hudson Engineering Corp.) Gas and liquid contact apparatus.

2,693,997 (Standard Oil Development Co.) Storage of high boiling distillate fractions in presence of phenolic antioxidant and soluble chromate corrosion inhibitor.

2,694,034 (Universal Oil Products Co.) Treatment of saturated distillates to reduce mercaptans by adding olefins, phenylene diamine inhibitor and oxygen.

2,694,605 (Union Oil Co. of Calif.) Adsorption process, using impactless separator-chamber.

2,694,671 (Standard Oil Development Co.) Selective hydrogenation process for cracked naphtha using Ni-W catalyst.

2,694,682 (Calif. Research Corp.) Oil composition of improved oxidative stability, using thiocarbonic acid derivative and methyl naphthalene.

2,695,262 (Phillips Petroleum Co.) Production of low aniline point oil by solvent extraction.

2,695,265 (Standard Oil Co. (Ind.) Cut C_5 separation of cracked naphthas.

2,695,281 (Phillips Petroleum Co.) Method of forming urea and thiourea complexes.

2,695,322 (Phillips Petroleum Co.) Separation of naphthenes from a saturated hydrocarbon mixture with the use of methyl alcohol and water.

2,695,865 (Sun Oil Co.) Solvent extraction of mineral lubricating oils.

2,695,868 (Metallgesellschaft Aktiengesellschaft) Method and apparatus for treating liquids with gases or vapors.

2,695,882-91 (Petrolite Corp.) Breaking petroleum emulsions.

Catalysts

2,691,455 (Socony-Vacuum Oil Co. Inc.) Reactivation of siliceous catalyst by removal of nickel with acetylacetone.

2,691,457 (Socony-Vacuum Oil Co. Inc.) Treatment of porous solids with acetylacetone.

2,694,049 (Imperial Chem. Industries Ltd.) Titanium oxide and tungsten oxide containing catalyst.

2,694,676 (Standard Oil Development Co.) Activation of sodium contaminated synthetic silica-alumina catalyst with hydrogen fluoride.

2,694,686 (Standard Oil Development Co.) Phosphoric acid catalysts comprising a calcined silicon phosphoric base.

2,695,893 (Eugene J. Houdry) Catalysis and manufacture of catalytic masses containing minute pores.

2,694,048 (Universal Oil Products Co.) Manufacture of improved solid phosphoric catalysts.

Conversions

2,691,395 (Union Oil Co. of Calif.) Solids conveyance.

2,694,002 (Phillips Petroleum Co.) Polymerization of olefins, using silica-alumina catalyst.

2,694,035 (Standard Oil Development Co.) Distillation of oil-bearing minerals in two stages in the presence of hydrogen.

2,694,036 (Houdry Process Corp.) Lifting fluent solids in hydrocarbon conversion systems.

2,694,038 (Phillips Petroleum Co.) Method for manufacturing coke from hydrocarbon, oil, using heated coke particles.

2,694,096 (Phillips Petroleum Co.) Method and apparatus for independently controlling reaction time and temperature for hydrocarbon conversion (using pebble heat exchanger).

2,694,672 (Standard Oil Development Co.) Hydroforming of hydrocarbons.

2,694,673 (Standard Oil Development Co.) Catalytic cracking of hydrocarbon oils with specific pore size silica-alumina catalysts.

2,695,197 (Houdry Process Corp.) Solids lift discharger.

2,695,212 (Union Oil Co. of Calif.) Handling of granular solids.

2,695,220 (Socony-Vacuum Oil Co.) Kiln.

2,695,268 (Standard Oil Development Co.) Visbreaking of heavy hydrocarbonaceous materials.

2,695,265 (M. W. Kellogg Co.) Injection mixer for use in catalytic hydrocarbon conversion processes.

2,695,266 (Socony-Vacuum Oil Co.) Method and apparatus for the regeneration of granular contact material.

2,695,325 (Phillips Petroleum Co.) Isomerization process using Al Cl_3 and Fe Cl_3.

2,695,326 (Standard Oil Development Co.) C_{11} to C_{13} copolymers of propene and n-butane.

2,695,327 (K. Ziegler, et al) Dimerization of unsaturated hydrocarbons.

2,695,815 (Socony-Vacuum Oil Co.) Method and apparatus for pneumatic transfer of granular contact material in moving-bed hydrocarbon conversion processes.

2,695,866 (M. W. Kellogg Co.) Desulfurizing and reforming naphthas with Cr-Mo catalyst in presence of hydrogen.

Hydrocarbon Synthesis

2,693,481 (Socony-Vacuum Oil Co.) Method for conditioning metal oxide catalysts in Fischer-Tropsch process.

2,693,497 (Shell Development Co.) Synthesis of unsaturated hydrocarbons (methyl pentadiene) from unsaturated ketones.

2,694,087 (Gulf Research & Development Co.) Production of gas comprising hydrogen and carbon monoxide.

PRODUCTS

Chemicals

2,693,461 (Phillips Petroleum Co.) Synthetic elastomer hydrogenation process during hot milling.

2,693,482 (Calif. Research Corp.) Preparation of alkkene phosphonous acids.

2,693,486 (Standard Oil Co., Ind.) Preparation of purified petroleum sulfonates, using alcohols and thiurane.

2,693,493 (Standard Oil Development Co.) Separation of oxo alcohols.

2,694,003 (The Texas Co.) Combustion engine generation of feed gas for ammonia synthesis.

2,694,053 (Phillips Petroleum Co.) Trimethylene polyamines as activators for emulsion polymerization reactions.

2,694,694 (Standard Oil Development Co.) Polymerization process using vinyl chloride as diluent.

2,694,074-5 (The Texas Co.) Production of thiophene compounds.

2,694,084 (Standard Oil Development Co.) Reaction product of a diorganic ester of dithiophosphoric acid with a sulfonating agent and the process for making same.

2,694,091 (Imperial Chemical Industries Ltd.) Oxo process using mixture of alkenes and dienes.

2,694,095 (American Cyanamid Co.) Alkylation of aromatic hydrocarbons.

2,694,701 (M. W. Kellogg Co.) Manufacture of perhalogenated polymers under controlled conditions.

2,694,730 (Universal Oil Products Co.) Derivatives of bicyclooctene hydrocarbons and production thereof.

2,694,734 (Eastman Kodak Co.) Production of normal oxygenated compounds by reacting propylene with CO and hydrogen.

2,695,292 (Phillips Petroleum Co.) Production of 4-amino pyrimidines.

2,695,030 (Union Oil Co. of Calif.) Amides of oxidized paraffin wax.

2,695,312 (Calif. Research Corp.) Preparation of aromatic carboxylic acids by heating hydrocarbon with sulfur and ammonia.

2,695,313 (Calif. Research Corp.) Oxidation of nonaromatic organic compounds, using sulfur, etc.

2,695,315 (Standard Oil Development Co.) Synthesis of oxygenated organic compounds from CO, hydrogen and olefins.

2,695,316 (Phillips Petroleum Co.) Catalytic preparation of polysulfides from alkyl sulfides.

2,695,321 (Phillips Petroleum Co.) Recovery of perfluoro carbon compounds.

2,695,323 (Calif. Research Corp.) Production of para xylene.

2,695,324 (Calif. Research Corp.) Hydrocarbon purification process (isopropyl aromatic hydrocarbons).

2,695,834 (Shell Development Co.) Process of reacting unsaturated compounds with inorganic acid compounds and products resulting therefrom, to produce synthetic filament.

2,695,867 (Stone and Webster Engineering Co.) Combination extraction and distillation process for separating pyridine, propanol and MEK.

2,695,913 (Universal Oil Product Co.) Alkylaryl urethanes.

Fuels

2,693,077 (Aerojet-General Corp.) Reaction motor operable by liquid propellants and method of operating it with hydrazine and carbon disulfide-containing phosphorus.

2,693,947 (The Aerogen Co., Ltd.) Gas manufacture (hydrogen, coal gas and petrol vapor).

2,693,999 (Standard Oil Development Co.) Desulfurization of petroleum coke with oxygen-containing gas.

2,694,623 (Standard Oil Development Co.) Process for enrichment of water gas, using iron oxide.

2,694,624 (Standard Oil Development Co.) Production of gas of high calorific value, using iron oxide catalyst.

2,695,011 (Standard Oil Development Co.) Method of operating compression ignition engines with gasoline inspiration.

2,695,222 (Universal Oil Products Co.) Stabilization of blended burner oils with primary alkanol amine.

2,695,223 (The Standard Oil Co.—Ohio) Furnace oils containing organic phosphorus compounds to minimize carbon deposition.

Lubricants

2,693,447 (Standard Oil Co., Ind.) Lubricants containing metal salts of fatty acid derivatives of dithiocarbamic acid.

2,693,448 (Socony-Vacuum Oil Co.) Demulsified antirust turbine oil containing phenolic antioxidant, TEA oleate antirust, and demulsifier.

2,693,449 (Geo. M. Hain & Wm. A. Zisman) Silicone greases.

2,693,450 (The Texas Co.) Wire rope lubricant comprising a blown residuum, a petroleum wax, and a light chlorinated hydrocarbon.

2,694,044 (Standard Oil Development Co.) Stabilization of phosphosulfurized hydrocarbon additive with fatty acid ester.

2,694,046 (Sinclair Refining Co.) Lubricating oil composition containing sulfurized pinene, etc.

2,694,683 (Standard Oil Development Co.) Lubricating grease containing pectic acid salt.

2,694,684 (Standard Oil Development Co.) Lubricating oil compositions containing phosphoric copolymer pour depressant.

2,694,685 (Standard Oil Development Co.) Maleinoid-vinyl copolymer and its use in lubricants.

2,695,271 (The Standard Oil Co.—Ohio) Method of treating hydrocarbon base lubricants with a phosphorus sulfide in the presence of butyl rubber.

2,695,272 (Standard Oil Development Co.) Soluble metalworking oil containing sulfonates.

2,695,273 (American Cyanamid Co.) Lubricating oil compositions containing methylene bis (methyl tert. butyl phenol) and sulfonate to reduce lacquer formation.

2,695,877 (Socony-Vacuum Oil Co.) Water-in-oil soluble lubricating oil.

2,695,878 (Sinclair Refining Co.) Greases containing a lithium soap of polymerized 12-hydroxy stearic acid and their method of manufacture.

2,695,880 (Du Pont Co.) Telomer greases containing chloroform telomers of monochlorotrifluoroethylene, etc.

2,695,910 (Lubrizol Corp.) Methods of preparation of superbased salts.

Specialties

2,693,425 (Standard Oil Co.—Ohio) Asphalt cement of improved wetting properties, containing acidic organic phosphorus compound.

2,693,441 (Phillips Petroleum Co.) Feed preparation for furnace black production.

2,693,451 (The Texas Co.) Two-phase permanent antifreeze fluid containing polyhydric alcohol and silicone.

2,694,014 (Gulf Research & Development Co.) Paraffin wax compositions containing alpha coniendrol antioxidant.

2,694,045 (Standard Oil Development Co.) Stabilizer for petroleum products (thiocyanate derivative).

2,694,073 (Shell Development Co.) Halogenated heterocyclic insect toxicant and process of preparing same.

2,694,621 (Michael Steinschlaeger) Process for the manufacture of carbon black.

2,694,645 (Universal Oil Products Co.) Stabilization process, using alkylated flavone.

2,695,219 (Phillips Petroleum Co.) Detection of corrosion and damage to apparatus by use of temperature-sensitive devices.

2,695,277 (Socony-Vacuum Oil Co.) Aqueous resin-wax floor-coating dispersions.

2,695,837 (Phillips Petroleum Co.) Process for producing pelleted furnace carbon black.

2,695,838 (Schabelitz Biochemical Corp.) Process for recovery of resins, waxes, and oils from peat.

2,695,848 (Tide Water Associated Oil Co.) Rust-preventive compositions containing alkylol amine sulfonate.

2,695,859 (Shell Development Co.) 1-Chloro-3 bromopropene-1 as a soil fumigant and method of using same.

2,695,876 (The Texas Co.) Prevention of corrosion of iron by aqueous brines, using zinc chromate solution.

2,695,879 (Socony-Vacuum Oil Co.) Antifoamant composition containing sorbitol compounds.

Miscellaneous

2,693,085 (Standard Oil Development Co.) Hydraulic submarine ditcher.

2,693,175 (Standard Oil Development Co.) Method and means for preventing carburetor icing.

2,693,942 (Gulf Oil Corp.) Heat transfer apparatus.

2,694,923 (Phillips Petroleum Co.) System for gas analysis.

EQUIPMENT

Processing, general

2,693,091 (Boris Masing) Heat exchange unit of an absorption refrigerating apparatus.

2,693,229 (Joseph S. Fagan) Gaseous heater.

2,693,280 (Hadley R. Brame) Separating apparatus.

2,693,281 (Bendix Aviation Corp.) Filter.

2,693,346 (Lars K. H. Petersen) Liquid heater.

2,693,352 (Frederick S. Bloom) Furnace insulation system.

2,693,849 (Perfection Stove Co.) Vaporizer-type liquid fuel-burning apparatus and electrical ignition means.

2,693,879 (Duane C. Gehrman) Apparatus for transporting solids into or from a gas or liquid.

2,693,880 (Otto B. Schoenfeld) Emulsion separator.

2,693,882 (Olson Filtration Engineers) Backwash filter.

2,693,913 (Perfection Stove Co.) Ignition and fuel control means for liquid fuel burners.

2,693,942 (Gulf Oil Corp.) Heat transfer apparatus.

2,693,946 (Herbert Simpson Corp.) Apparatus for separating dust from water or other liquids.

2,693,947 (Aerogen Co. Ltd.) Gas manufacture.

2,693,948 (Hudson Engineering Corp.) Gas and liquid contact apparatus.

2,693,949 (Koch Engineering Co.) Apparatus for contacting gases and liquids.

2,693,950 (Joy Mfg. Co.) Dust wetting and removing apparatus.

2,693,999 (Standard Oil Development Co.) Desulfurization of petroleum coke.

2,694, 037 (Shell Development Co.) Apparatus for producing shale oil from oil shale.

2,694,039 (Socony-Vacuum Oil Co.) Apparatus for solid transfer.

2,694,492 (Hans Rumpf and Fritz Kaiser) Apparatus for classifying materials in liquid and gaseous media.

2,694,622 (Union Oil Co. of Calif.) Hydrocarbon refining apparatus.

2,694,675 (Walter H. Hogan) Multistage centrifugal rectification apparatus.

2,694,676 (Maxim Silencer Co.) Evaporator construction.

2,694,765 (Turbine Equipment Co.) Electric heater.

2,694,133 (Herbert R. Drury) Centrifugal separator.

2,695,197 (Houdry Process Corp.) Solids lift discharger.

2,695,220 (Socony-Vacuum Oil Co.) Kiln.

2,695,599 (Combustion Engineering Inc.) Superheat temperature control by overfire air.

2,695,679 (United Aircraft Products) Oil deaeration.

2,695,681 (W. W. Sly Mfg. Co.) Dust filter.
2,695,773 (Carrier Corp.) Cooling tower.
2,695,836 (Phillips Petroleum Co.) Apparatus for control of gas treatment.
2,695,868 (Metallgesellschaft Akt.) Apparatus for treating liquids with gases or vapors.
2,695,869 (Metallgesellschaft Akt.) Distillation of organic liquids.
2,695,870 (Carl Otto) Apparatus for distilling ammonia.
2,695,871 (Abbott Laboratories) Rotary molecular vacuum still.
2,695,922 (Joseph Matejka) Carbon-depositing furnace.

Catalytic Reactors

2,693,395 (Union Oil Co. of Calif.) Solids conveyance.
2,695,265 (M. W. Kellogg Co.) Injection mixer for use in catalytic hydrocarbon conversion processes.
2,695,266 (Socony-Vacuum Oil Co.) Apparatus for regenerating granular contact materials.
2,695,815 (Socony-Vacuum Oil Co.) Apparatus for pneumatic transfer of granular contact material in moving-bed hydrocarbon conversion process.

Instruments

2,693,103 (Hartmann & Braun Akt.) Magnetic gas-measuring instrument.
2,693,105 (Sperry Products, Inc.) Ultrasonic inspection device.
2,693,106 (Sperry Products Inc.) Resonance device for inspecting materials.
2,693,111 (Reaction Motors Inc.) Fuel or propellant gage.
2,693,112 (Manning, Manning, & Moore) Thermometer.
2,693,113 (Merriam Instrument Co.) Pressure and temperature compensating scale for manometers.
2,693,114 (Gilbert & Barker Mfg. Co.) Automatic pipe line sampling apparatus.
2,693,196 (Neptune Meter Co.) Apparatus for dispensing measured quantities of liquid.
2,693,517 (Tappan Stove Co.) Temperature responsive switch.
2,693,518 (Milwaukee Gas Specialty Co.) Thermostat.
2,693,700 (Atomic Energy Commission) Pressure-ascertaining means.
2,693,701 (Sprague Meter Co.) Gas meter diaphragm.
2,693,702 (Buffalo Eclipse Corp.) High-pressure liquid-level gage.
2,693,705 (Atomic Energy Commission) Liquid sampler.
2,693,820 (Sam P. Jones) Pressure regulator.
2,694,171 (Julian A. Campbell) Electric motor system for liquid-level control.
2,694,313 (Bethlehem Steel Co.) Brush thermocouple temperature-measuring apparatus.
2,694,315 (Foxboro Co.) Pneumatic control device.
2,694,340 (Ernst Leitz B.m.b.H.) Interference microscope.
2,694,385 (Combustion Engineering) Size identified mounting means for flow-restricting orifices.
2,694,506 (Knapp-Monarch Co.) Pressure bulb and puncturing means.
2,694,566 (Kurt Wolter) Force-measuring device.
2,694,928 (Mine Safety Appliances Co.) Electrical system for measuring the rate of motion of a fluid.
2,694,930 (Weston Electrical Instrument Corp.) Temperature-measuring apparatus.
2,695,030 (American Enka Corp.) Remote liquid level control.
2,695,353 (American Cyanamid Co.) Constant temperature control apparatus.
2,695,453 (Edward L. Valentine) Dip stick liquid measuring apparatus.
2,695,514 (Cutler-Hammer Inc.) Dew point indicator.
2,695,521 (Nicholas G. Nazarenko) Temperature responsive measuring instrument.
2,695,623 (Page Oil Tools, Inc.) Flow control for fluid-handling lines.
2,695,625 (Gifford-Hill-Western Inc.) Butterfly valve.
2,695,765 (Minneapolis-Honeywell Regulator Co.) Snap-acting fluid metering valve device.

Pumps & Compressors

2,693,149 (Howard T. White) Explosionproof motor-driven pump.
2,693,150 (Smith's Jacking Systems Ltd.) Pump.
2,693,313 (Wetmore Hodges & Assoc.) Motor pump or compressor package.
2,693,762-3 (De Laval Steam Turbine Co.) Non-positive screw pump and motor.
2,693,764 (Richard T. Cornelius) Wabble pump.
2,693,765 (American Optical Co.) Fluid pump and method of making same.
2,693,766 (Leon Antoine Seyler) Rotary pump of the resilient tube type.
2,693,768 (Eberhard E. Wettley) Dual purpose pump.
2,693,901 (Nash Engineering Co.) Hydroturbine pump.
2,693,904 (A. V. Roe Canada Ltd.) Air bleed for compressors.
2,693,805 (Power Jets Ltd.) Elastic fluid compressor.
2,694,367 (Paragon Gear Works) Rotary pump.
2,694,519 (Joy Mfg. Co.) Pump speed controlling and unloading means.
2,694,979 (Borg-Warner Corp.) Overspeed control for air turbine-driven pumps.
2,694,981 (Roland H. Daugherty, et al) Centrifugal pump.
2,694,983 (Rockwell Mfg. Co.) Rotor vane control.
2,695,564 (Perry I. Nagle) Priming device for pumps.
2,695,565 (Ludwik R. Seinfeld) Diaphragm mechanism.
2,695,566 (Borg-Warner Corp.) Pump, bushing graduated pressure-responsive areas.

Valves & Fittings

2,693,110 (Charles E. Terrell) Valve embodying fluid-measuring means.
2,693,198 (Neill McKay Heath) Automatic shutoff valve.
2,693,199 (Clair W. Sims) Renewable valve.
2,693,201 (John S. Page) Valve.
2,693,202 (Gilbert & Barker Mfg. Co.) Fluid-conducting for rotary valve.
2,693,203 (McDowell Mfg. Co.) Gated valve.
2,693,337 (Duriron Co.) Valve for corrosive fluids.
2,693,338 (Max Grunt) Valve.
2,693,815 (Mueller Co.) Valve.
2,693,816 (Milwaukee Valve Co.) Hydrant valve.
2,693,817 (McDonald and Miller) Feeder valve.
2,693,818 (Wyandotte Chemicals Corp.) Multiple plate valve.
2,693,819 (Herbert C. Otis) Safety control device.
2,693,821 (Cornelius Co.) Relief valve.
2,693,822 (Consolidated Vacuum Co.) Piston-operated valve with leak detection means.
2,693,823 (Minneapolis-Honeywell Regulator Co.) Pilot-controlled diaphragm valve and pressure regulator.
2,693,826 (R. M. Vaughan and Lawrence F. Leavitt) Water-mixing valve and assembly.
2,693,929 (Charles W. Hart) Solenoid-operated valve.
2,693,930 (M. T. Gossett) Electromagnetic reversing valve.
2,693,931 (Boeing Airplane Co.) Self-closing valve with retarding device automatically regulated according to flow velocity.
2,693,932 (Lorenzo A. Richards) Vacuum-operated diaphragm valve.
2,693,933 (Arthur E. Meinke) Stop valve.
2,693,934 (S. C. Johnson & Son) Valve handle retainer.
2,694,320 (Philadelphia Gear Works) Valve control.
2,694,405 (Howard Field Jr.) Automatic shutoff valve for hydraulic transmission systems.
2,694,406 (U. S. Air Force) Constant flow fuel valve.
2,694,407 (Elizabeth Klein Johnson) Safety device for fluid pressure pipe lines.
2,694,408 (Fred W. McRae) Valve control mechanism.
2,694,410 (Victor Ey) Fluid pressure regulator.
2,694,411 (Etablissements Neyrpic) Self-centering valve with spring of slight lateral stability.
2,694,412 (Stanley E. Jaros) Multiposition fluid valve.
2,694,413 (Homestead Valve Mfg. Co.) Protected seal for fluid valves.
2,694,494 (Western States Machine Co.) Centrifugal basket valve mechanism.
2,694,497 (Arthur J. Stock) Valve-operating mechanism.
2,694,503 (Aerojet-General Corp.) Diaphragm safety device.
2,694,544 (Atkomatic Valve Co.) Pressure-actuated valve.
2,694,545 (G. Dikkers & Co.) Fluid pressure-operated valve.
2,694,547 (Edward Valves Inc.) Valve structure.
2,694,548 (Robert O. Stekoll) Valve assembly.
2,695,031 (Arthur N. Asselin) Valve.
2,695,032 (Mcdonnell & Miller, Inc.) Pressure-relief valve.
2,695,154 (Detroit Controls Corp.) Solenoid valve.
2,695,155 (Vulcan Research Corp.) Plate valve.
2,695,184 (James C. Hobbs) Temperature compensated fluidtight joint.
2,695,186 (Detroit Gasket & Mfg. Co.) Metal gasket.
2,695,446 (Metallschlauchfabrik) Method making a tube-to-flange connection.
2,695,626 (Automatic Pump and Softener Corp.) Float valve mechanism.
2,695,628 (Norton Co.) Check valve.
2,695,633 (Leland S. Hame) Line blind.
2,695,766 (Bridgeport Brass Co.) Intermittently-acting fluid valving device.
2,695,796 (George V. Woodling) Coupling sleeve connection.
2,695,798 (Hoover Co.) Pipe coupling.

Miscellaneous

2,693,015 (Freddie B. Richards and Roger W. McBrien) Clamp for chemical apparatus.
2,694,922 (Vitron Research Corp.) Apparatus for temperature-pressure testing materials.

You name the metal or plastic

WE'LL MAKE THE

Swagelok®

TUBE FITTINGS

EASY TO USE . . . . . .

NO SPECIAL TOOLS NEEDED

NO FLARING OR THREADING

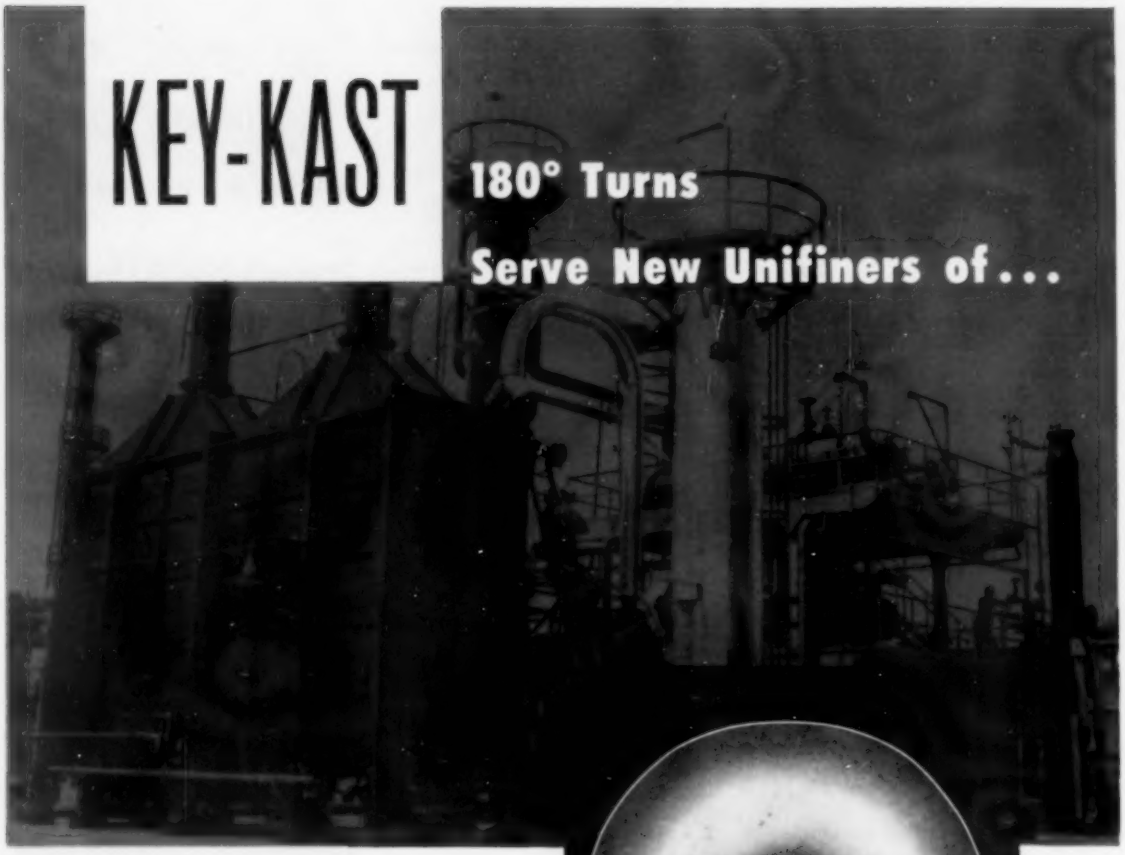
From stock or on special order, you can get Swagelok Tube Fittings in any metal you require ranging from titanium to brass — *in fact, any machinable metal or plastic.* When you use Swagelok Tube Fittings every joint is leakproof. No bothersome small leaks to cause shut-downs. Tubing is rigidly supported, thereby avoiding vibration. No torque is transmitted to the tubing. Swagelok Tube Fittings can be used on heavy or thin wall tubing of every tube material, including plastic. Plus the fact that Swagelok joints are easier and faster to make. Get the facts now.

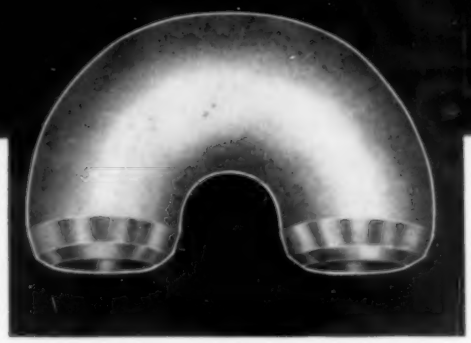
FREE: For complete information write for the Swagelok catalog. Address Dept. D1.

CRAWFORD FITTING CO.
884 E. 140th Street
Cleveland 10, Ohio

KEY-KAST

180° Turns Serve New Unifiners of...





EASTERN STATES PETROLEUM CO.

Finished in the record-breaking time of eight weeks, the new Unifiner of Eastern States Petroleum Co., Inc., Houston, Tex., is producing at a capacity even greater than anticipated—a tribute to the skill of the men who designed and built it, and to the quality of the materials used in its construction.

KEY-KAST 180° weldable U-bends were selected to serve the piping system of this efficient new Unifiner. More and more refineries, in fact, are specifying KEY-KAST fittings because KEY-KAST offers these outstanding advantages:

- Greater wall thickness throughout — for increased structural strength
- Extra thickness in critical areas — for greater allowance against erosion
- Lower unit cost
- Meet A.S.M.E. and A.S.A. Codes
- Rigid testing and inspection to meet high standards of quality

There's a Key-Kast fitting for every alloy piping need. Write for complete information.

Key company

Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

P. O. BOX 4540 EAST ST. LOUIS, ILLINOIS

DISTRICT OFFICES: NEW YORK • CLEVELAND
CHICAGO • TULSA • HOUSTON • LOS ANGELES

PERSONALS

FIFTY YEARS IN THE OIL BUSINESS, a long time to most people, isn't even a record in the family of Percy Russell (second from right, foreground). H. A. Jackson, general manager of Tide Water Assoc. Oil Co.'s eastern division, is shown giving him an engraved wrist-watch to mark his retirement after 50 years at the Bayonne, N. J., refinery. At Percy Russell's side is Elliot Russell, who retired from the refinery in 1951 with 50 years' service. Alongside Mr. Jackson is Harry Russell, who set the family record with 55 years when he retired from Bayonne in the same year. Witnesses are (left to right, background) William Higgins and S. W. Candee, employee relations, and H. S. Chase, eastern division's manager of manufacturing.

Arthur T. Proudfit has been elected a director of the Standard Oil Co. (N. J.). Mr. Proudfit resigned his position as president of the Creole Petroleum Corp., Jersey's Venezuela affiliate, to take over his new duties in New York.

After having attended Oregon Agricultural College he joined the Huasteca Petroleum Co. in 1919 as a tool dresser in Tampico, Mexico. He remained with the company until 1927, eventually becoming superintendent of drilling. Mr. Proudfit then transferred to the Lago Petroleum Corp. and worked as a superintendent in Venezuela. In 1936 he moved to Standard Oil Co. of Argentina as supervisor of producing fields in that country.

Two years after this Mr. Proudfit left Argentina and became a manager for Standard Oil Co. of Venezuela. He was appointed general manager of the company in 1942. When Creole took over the operations he became the new firm's general manager. The final two steps were taken in 1944, when he was promoted to vice-president, and 1945, when he was elected president of the Creole company.

John J. Waybright has been made Jersey Standard's refining coordinator of North American refining activities. He has moved to New York from Everett, Mass., where he has been the refinery manager for Esso Standard Oil Co. A graduate of the United States Naval Academy in 1934, Mr. Waybright joined Esso's Eagle Works the same year as a student engineer.

After promotions in engineering, economics and cost analysis, he became assistant to the general superintendent of the Bayway refinery.

From the Standard Oil Development Co., **Paul J. Harrington** has been appointed general technical advisor for technical and associated economic problems in the coordination of Jersey refineries. At SOD, Mr. Harrington had been assistant chief engineer since 1950. He joined what is now Esso Standard Oil Co. in 1929, two years after receiving his master's degree in chemical engineering from M. I. T.

Starting in the technical service division at the Bayway refinery, he advanced through test and survey work until his appointment as head of the process test division of SOD.

Dr. Everett C. Hughes, chief of the chemical and physical research division of the Standard Oil Co. of Ohio, has been elected chairman of the American Chemical Society's Division of Petroleum Chemistry. He succeeds Prof. Frederick D. Rossini, head of the department of chemistry at the Carnegie Institute of Technology.

Chairman-elect, who will succeed Dr. Hughes in 1956, is **Dr. Alex G. Oblad,** director of chemical research for the Houdry Process Corp. Dr. Oblad's present job of managing editor of the Petroleum Division's publications will be taken over by **Dr. Robert K. Smith,** chief of Houdry's exploratory research section.

Wheeler G. Lovell, associate director of research at the Ethyl Corp., Detroit, was re-elected secretary-treasurer.

Carl G. Minnig has retired as a vice-president of the Witco Chemical Co. and serves the company now as a consultant.

For a number of years Mr. Minnig was active in the development of new sources of gas supply for the manufacture of carbon black and did much to promote the use of gas in industry. In 1937 he joined Witco and has represented the company in many places throughout the United States.

Dr. Carl O. Tongberg and **Dr. Amiot P. Hewlett** have been appointed vice-presidents of the Standard Oil Development Co.

Dr. Tongberg was previously co-

Dr. Tongberg

Dr. Hewlett

ordinator of research and development of products. Dr. Hewlett was general administration manager. Dr. Tongberg was also named to the executive committee and elected a director. He joined the company in 1937 and has since held a number of positions, including that of director of the research division. He was given the post of coordinator in January of 1954, and as such was responsible for all work on the research and development of petroleum products.

Dr. Tongberg's B.S. and M.S. degrees were taken at Harvard University. For his doctorate he studied at Pennsylvania State University.

Dr. Hewlett obtained his B.S. and M.S. from Mississippi College in 1921, and his Ph.D. in 1930 from Iowa State College. During the interim he taught at several institutions, including Georgia Tech, where he was an assistant professor of chemistry. In 1930 he joined SOD, becoming eventually manager of the process division and

employee relations advisor to the parent company, Standard Oil of New Jersey.

John A. Tench has been appointed to succeed the late **Paul A. Hurley** as manager of the Shell Oil's Houston refinery. Mr. Tench has been

Mr. Tench

Mr. Stolley

replaced as manager at the Martinez refinery by **Bruno Stolley,** previously manager of Shell Development Co.'s Emeryville laboratory. This job has been taken by **John R. Morrison,** who was assistant manager of the company's industrial relations department.

Mr. Morrison

Mr. Tench has been with Shell for 26 years. From 1939 to 1946 he was in charge of operations in the San Francisco office manufacturing department. He became superintendent at Martinez in 1946 and was promoted to manager in 1949.

Mr. Stolley, who started with the company in 1929, became assistant chief engineer at Houston in 1934. In 1946 he was appointed assistant manager of head office personnel department in New York. He was named manager at Emeryville in 1949.

Mr. Morrison joined Shell at the Houston refinery in 1938. He was named the refinery's assistant industrial relations manager in 1946. In 1948 he was transferred to New York and in 1951 became manager of the policy and training division of the personnel department. Early in 1954 he was advanced to assistant manager of the industrial relations department.

Wallace Everette Pratt, former vice-president and director of the Standard Oil Co. (N. J.), is the recipient of this year's American Petroleum Institute gold medal for distinguished achievement.

Mr. Pratt earned his college education at the University of Kansas by working at night in a hotel. Though he was graduated in 1907 he remained for two more years' work, eventually emerging with the degrees of B.A., B.S., M.A. and Mining Engineer. In 1909 he was employed by the Division of Mines of the Philippine Government and became its chief three years later. Returning to this country in 1916, he took employment as a geologist with The Texas Co. in Mexico, Costa Rico and Texas.

In 1918 Mr. Pratt affiliated himself with Humble Oil & Refining Co., first as chief geologist, then, in 1924, as director, and in 1930, as vice-president. Joining Standard of New Jersey in 1937 he became a director and member of that company's executive committee. In 1942 he was elected a vice-president, and in 1945 he retired from the company.

Mr. Pratt is the author of more than 100 papers on geological subjects, as well as of the book "Oil in the Earth."

H. B. Peters has been promoted from assistant to chief engineer of The Texas Co.'s refining department. He succeeds **David W. Carswell,** who has retired after 37 years with Texaco, the last 17 as chief engineer.

Francis Horton and **J. C. Neyland, Jr.,** were appointed to serve as assistant chief engineers along with R. E. Nagle, who continues in the post.

W. A. McMillan has been appointed assistant general manager of the newly organized research and technical department. The new manager of operations is **Gus Kaufman.**

In the research division **W. J. Coppoc** has been appointed manager, **T. C. Heisig,** assistant manager (products), and **C. E. Moser,** assistant manager (process).

New manager of the technical services division is **R. W. Hall. A. L. Brodie** is the new assistant manager (automotive), **M. L. Langworthy,** assistant manager (manufacturers' service), and **R. R. Thurston,** assistant manager (industrial products).

Ray E. Miller, advisor to the du Pont Co. and widely known throughout the oil industry, died November 17 in New York City. He was 56 years old.

In 1920 he became safety engineer and personnel manager for Harland Oil, since merged with Continental Oil Co. He joined Hanlon-Buchanan, Inc., a Tulsa oil company, in 1934 as a vice-president, a post he held until he became a vice-president and director of Warren Petroleum Corp. early in 1946. Later in 1946 he moved to the du Pont Co. as sales director for petroleum additives and eventually became sales director of the petroleum chemicals division. He resigned this post for reasons of health in 1953 and continued in an advisory capacity with the company.

Mr. Miller was on the board of directors of the American Petroleum Institute. He was executive secretary of the Natural Gasoline Association of America in the 1920s, and became the group's president for 1943-44.

He is survived by his widow, the former Dorothy E. Blanks; a daughter, Mrs. John B. Hogan of Forest Hills, L. I., and three grandchildren.

Appointments have been made to six new executive positions in the Standard Oil Development Co. The six are deputy coordinators assigned to the firm's six vice-presidents responsible for coordinating specific phases of operations.

Dr. F. L. Miller is deputy to W. C. Asbury for patents, contracts, legal matters and public relations. Dr. Miller has been director of the research division since he joined SOD in 1930. He was appointed manager of the contract, legal and patent department in 1953.

D. L. Campbell has been named deputy to E. J. Gohr for research and development work on fuel processes and analytical research. Mr. Campbell was employed by the company in 1928. He has been associate director of the process division since April of 1954.

W. F. Persons has been appointed deputy to Dr. A. P. Hewlett for general administration. Since joining the company in 1938 he has held several positions in the personnel field. He was made assistant director of employee relations in 1950.

C. E. Paules, named deputy to E. W. Luster for engineering, has been chief engineer of the Esso engineering department since 1949. He began with the company in 1919 and has held a number of positions in the engineering group.

Dr. W. J. Sweeney has **R. M. Shepardson** as deputy for petroleum products and medical research. Mr. Shepardson was appointed director of the process division in 1947. He joined SOD in 1930.

The final member of the group is **A. D. Green,** who has been deputized to Dr. C. O. Tongberg for chemical research and process research on lubes and specialty products. Mr. Green has been director of the development division since 1936 and an employee of the company since 1930.

Producers of . . . "The Metal Without an Equal"

AMPCO* METAL

. . . the special alloys that make good where other metals fail

HERE are some of the properties of Ampco Metal that help you keep production up, costs down:

- **Excellent resistance to corrosion in certain media.**
- **High tensile and compressive strength.**
- **Unusual resistance to wear from abrasion, erosion, and cavitation pitting.**
- **High physicals at extreme temperatures.**
- **High rate of heat transfer.**
- **High impact and fatigue values.**

Because it combines all of these qualities, Ampco Metal is often called The Metal Without an Equal.

No matter what you do — whether you work in the chemical or process industries, refine oil, run a steel mill, make stampings, generate power, or any of hundreds of other jobs, you can make Ampco Metal work for you. It saves operating headaches and production grief, because it often makes good where other metals fail.

These versatile special alloys fight wear, corrosion, impact, fatigue; give long life and dependable performance under the severest conditions. That's why they are widely used in such tough assignments as fractionating towers, exchanger components, slippers and screw-down nuts for blooming mill service, aircraft parts, dies, valves, bushings, and other punishing jobs.

Chances are Ampco Metal can help you, too. It's available in sand and centrifugal castings, sheets, plates, bars, tubes, extrusions, welding wire and electrodes. Consult your nearby Ampco field engineer or write us for full information.

*Reg. U. S. Pat. Off.

AMPCO METAL, INC.
Dept. PP-1 • Milwaukee 46, Wisconsin
West Coast Plant, Burbank, California

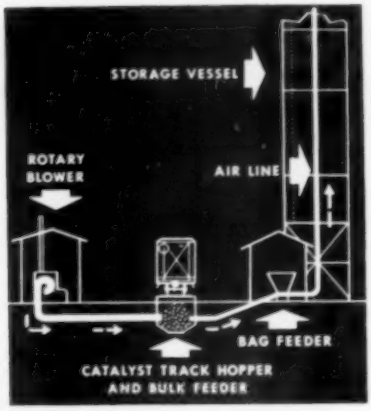
Ampco Metal, Inc.
Dept. PP-1 • Milwaukee 46, Wisconsin

I am interested in learning more about the properties and uses of Ampco Metal in the process industries. Please send me literature.

Name _____ Title _____
Company _____
Company Address _____
City _____ ( ) State _____
PP-1-55

Capsule Case History:

...before you leap

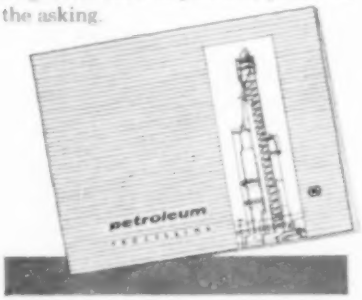


A careful look by Kaiser Engineers often results in departure from traditional methods in developing plant designs that anticipate the client's needs for future expansion and improvements. Numerous examples of this type of cost-saving engineering foresight are to be found in work performed by Kaiser Engineers in the broad fields of industrial design and construction.

During Design Of A Refinery Expansion which included a Houdriflow moving-bed cat-cracker, Kaiser Engineers departed from the ordinary method of handling bulk catalyst. Result—a unique all-weather continuous system moving 7½ tons of catalyst per hour by high-velocity air stream.

Discontent With Normal Practice produced a more efficient operation with a maximum attrition guaranteed at not more than 2%. Another case where a fresh approach paid off. This look-ahead service by the KE team is available to your firm for the design and construction of your next petroleum or petrochemical project.

A new brochure on petroleum processing (No. 103) is just out, yours for the asking.



kaiser engineers...*for low operating costs*

DIVISION OF HENRY J. KAISER COMPANY

ENGINEERS KE CONTRACTORS

• HOME OFFICE: KAISER BUILDING, OAKLAND 12, CALIFORNIA (CABLE: KAISENGS) NEW YORK, PITTSBURGH, LOS ANGELES, WASHINGTON, D. C.
• HENRY J. KAISER CONSTRUCTION CO. • HENRY J. KAISER COMPANY (Canada) LTD., MONTREAL

Noll Marks Decade wth Houdry

Ten years with Houdry Process Corp. have been completed by Henry D. Noll, director of the company's engineering division. He joined the company in 1944, already with 20 years of experience in the petroleum business behind him. Four years later he was made manager of engineering, and in 1952 a director.

Mr. Noll made his first contact with the oil industry in 1922, between semesters of engineering study at the University of Colorado. In 1925 he was graduated from the University of Pittsburgh, where he attended one of the first courses in petroleum refining given in the United States.

The former Standard Oil Co. of New York, now Socony-Vacuum, gave Mr. Noll his first full-time employment. In 1929 he was transferred to an affiliate, the Magnolia Petroleum Co., Beaumont, Texas, where he eventually managed the technical service unit.

Nine years later he rejoined Socony as the director of catalytic and thermal cracking research in the research and development division at Paulsboro, N. J. During World War II he coordinated Socony's aviation petroleum production. Mr. Noll holds 20 patents, mostly on cracking operations.

Fluor Opens Research Center

The research division of the Fluor Corp. moved into its new, permanent quarters at Whittier, Calif., in mid-October. The building contains 17,000 sq. ft. of office and laboratory space, as well as two acres outdoors devoted to pilot plant construction and operation.

In the pilot plant area the projects in operation at present include a pilot compressor station, a plant for fertilizer studies, a solvent extraction test plant, evaporative cooling test apparatus, and a unit for checking the performance of heat exchangers. The building has, in addition to office space, nine laboratories, a machine shop, photographic darkroom, and stock rooms.

Globe Steel Purchased by B&W

Globe Steel Tubes Co. of Milwaukee, Wis., has been purchased by the Babcock & Wilcox Co. and added to the company's Tubular Products Division. The Milwaukee firm was sold for approximately $9,300,000.

Operations at the plant are expected to continue without interruption and present production personnel will be retained. Key members of management will remain as employees of Babcock & Wilcox.

Globe Steel Tubes manufactures seamless and welded stainless, alloy and carbon steel tubing as well as a variety of aircraft tubing, pressure tubing and welding fittings. The acquisition is expected to broaden the range of items made by the Tubular Products Division.

Honeywell Buys Doelcam

Minneapolis - Honeywell Regulator Co. has acquired facilities for manufacture of precision instrument and control equipment with the purchase of the Doelcam Corp. of Boston, Mass. The Doelcam firm has a main plant and administrative offices in Boston and another plant and engineering laboratories in Newton, Mass., with a total employment of more than 600 persons.

Minneapolis-Honeywell will operate these facilities as a new division of the company and with the Doelcam management unchanged. President and founder of the firm is John J. Wilson. Terms of the sale were not disclosed.

Among the products of the Doelcam firm are synchro motors, gyroscopic instruments, precision electromechanical servo components and electronic control and test equipment.

Radiation Firm Founded

Consulting service to industry about the practical applications of radiation is offered by a new firm, Radiation Applications, Inc., of New York City. The company also is able to conduct research and will issue a monthly publication providing analysis and evaluation of developments in the field of industrial irradiation.

Applications of radiation forseen for the petroleum refining industry are as a source of energy for promoting certain chemical reactions of basic interest. Some examples are isomerization, hydrocarbon cracking, polymerization, and the degrading of waxes.

On the company's board of associates are Dr. V. Lawrence Parsegian, formerly director of research in the New York operations office of the Atomic Energy Commission, now chairman of the engineering group at Rennselaer Polytechnic Institute; Dr. Elmer L. Gaden, Jr., director of the radiation research program, department of chemical engineering, Columbia University; Dr. W. Ralph Singleton, senior geneticist, Brookhaven National Laboratory; Dr. Ernest J. Henley, Columbia University department of chemical engineering; Bernard Manowitz, engineer in charge, fission products utilization project, Brookhaven National Laboratory; Edward Sargent, chemical engineer, formerly with the AEC as manager of the Cleveland area.

Smith Made PEMCO Chief Engr.

W. Scott Smith has been appointed chief engineer of the Petroleum Maintenance Co., Long Beach, Calif. The job gives him responsibility for sales engineering and personnel relations, though he will also act as administrative assistant to the company's manager, W. A. Thompson, Jr.

Mr. Smith

Before joining Petroleum Maintenance, Mr. Smith was chief engineer with Wilshire Oil Co., Inc. Here he had charge of construction and maintenance operations for all pipe line, storage and refinery facilities. Altogether, Mr. Smith has been in oil refinery work for some 31 years.

Selas Acquires Texas Factory

Selas Corp. of America acquired its first manufacturing facility in Texas recently with the purchase of Southwest Steel Plate Division in Houston. Selas will continue the plant's production under Selas' specifications, of pressure vessels and mobile compressors, and the location is expected to shorten deliveries to the company's customers in Texas and other parts of the southwest. The Houston plant will also serve the company's export market in South American refining areas.

The new plant is to be known as Selas Constructors, Inc., and will be under the direct management of R. T. Clare, Jr., who will become a vice-president and general manager of the company. The site of the factory is at 8312 Hempstead Ave.

ALCO Enters Process Pipe Field

The American Locomotive Co. has purchased the Central Pipe Fabricating and Supply Co. of Cincinnati,

Ohio, a move designed to meet the needs for prefabricated pipe of ALCO's customers in the chemical and petroleum processing fields.

The new property consists of two buildings on 16½ acres of land in an industrial area some 20 miles north of Cincinnati. The plant has a present capacity of approximately 200 tons of prefabricated process and power piping a month, ranging in size from 2½ in. to 24 in. However, these facilities are in the process of being expanded by ALCO. Manufacturing space is being increased, machine tools and heat-treating equipment installed, and a railroad siding constructed.

Foxboro Opens New Calif. Plant

Production has started in the Foxboro Co.'s new instrument service and assembly building at San Leandro, Calif. The factory more than doubles the company's West Coast manufacturing facilities, providing 8400 sq. ft. of space for the service, production and sales departments. The building is located on a three-acre site at 399 Preda St., close to the Oakland Municipal Airport and the Eastshore Freeway.

Completion of the San Leandro plant fulfills Foxboro's expansion program for the year. The first unit was the new facility opened at Dallas in April. The second third of the plan was completed in July, with the opening of a factory in Pittsburgh, Pa.

Subsidiary to Make Precipitators

A wholly owned subsidiary of the Research Corp. has been formed to carry on the engineering, manufacture and sales of Cottrell electrical precipitators, previously handled by the Research firm itself. The subsidiary, Research-Cottrell, Inc., has Joseph W. Barker, president and chairman of the parent organization, as its chairman. Howard Coonley, vice-president of Research Corp., is its vice-chairman. President of the company is Carl W. Hedberg, formerly vice-president of the parent firm and general manager of its precipitation division. Other vice-presidents are L. M. Roberts, formerly director of engineering, and P. F. Eilenberger, formerly director of manufacture.

The separation of the precipitation business from the Research Corp.'s grants and related functions will provide clear-cut distinctions between the industrial and charitable activities of the foundation. However, the parent firm will continue to receive the net earnings of the subsidiary's activities, which will help to provide funds for the foundation's grants for research, as in the past.

Headquarters of the subsidiary are at Bound Brook, N. J., where a $2,000,000 office and manufacturing plant was completed three years ago for precipitation activities. Sales offices in New York, Pittsburgh, Chicago and San Francisco will remain unchanged.

Personnel Changes

Pfaudler Co.—John P. Eberhart to manager of the sales subsidiary, Pfaudler Sales Co., of Portland, Ore.

CEC Instruments, Inc.—Eugene D. Pettler to resident field engineer in charge of the newly formed Seattle district office, at 1904 Third Ave., which will serve users in the states of Washington, Oregon, Idaho, Wyoming, and Montana, and in British Columbia, Alberta and Saskatchewan provinces.

International Business Machines Corp.—W. Homer Jennings to Detroit representative and LeRoy P. Stanton to Los Angeles representative of the electronic data processing machines department.

Orbit Valve Co.—Leon R. Cousland to representative in Kansas and the Texas Panhandle region.

Allied Chemical & Dye Corp.—C. G. Stupp to vice-president of the Barrett Division. He continues to head technical activities of the firm.

Babcock & Wilcox Co.—George W. Kessler to chief engineer of the boiler division.

Catawissa Valve & Fittings Co.—Nelson A. "Casey" Jones to mid-west division manager, with headquarters at Irving, Texas.

Dravo Corp.—Gustav Schwab, Jr., to manager of the Marietta, Ohio, pipe fabrication plant of the machinery division.

Marlow Pumps—F. R. Paris to assistant sales manager, supervising all Marlow district engineers west of the Mississippi.

Rockwell Mfg. Co.—Three new district managers: Dean Collins to the new Shreveport, La., office; Edward D. Propps to the Dallas office; and Herbert M. Logan to the Tulsa office. The Shreveport office is at 328 Rickou-Brewster Bldg.

National Aluminate Corp.—Robert H. Mudwilder to technical representative in the midwest for the Catalyst Division.

Permutit Co.—K. G. Barnhill and E. J. Connelley to sales engineers at Boston, Mass., and Cincinnati, Ohio, respectively.

Fluor Corp., Ltd.—L. O. Calkins to district sales manager of the new Denver, Colo., district sales office; William Bowles to district sales engineer.

Western Supply Co. — Richard Moses to sales and service representative of the heat exchanger division for the West Virginia area.

Expansion, Transition

Girdler Co., Gas Processes Division, has transferred the southwestern representative's office to 301 Wright Bldg., Tulsa, Okla.

Cochrane Corp., Philadelphia, has opened a New York district sales office at 261 Madison Ave. Joseph R. Denton is manager.

Rockwell Mfg. Co., Meter and Valve Div., has opened a west Texas branch office at Midland, Texas, and converted its Dallas sales office into a district as well as a regional headquarters.

Eimco Corp. has completed its research and development center at 301 S. Hicks Rd., Palatine, Ill. The center will be devoted primarily to work in the field of liquid-solids separation, though it will also house Eimco's central division sales and engineering offices.

Jones & Laughlin Steel Corp. plans to construct a new Container Division plant and office on the same property as the present plant near West Port Arthur, Texas. The new building will more than double the area now available for producing steel drums, and the old building will become a warehouse.

Robertshaw-Fulton Controls Co., Fielden Instrument Div., has a new sales office in Philadelphia for distribution of its products in metropolitan Philadelphia and eastern Pennsylvania. The office has assumed the functions of the Sheffler Gross Co., formerly the manufacturer's representative in this area.

Years Ahead

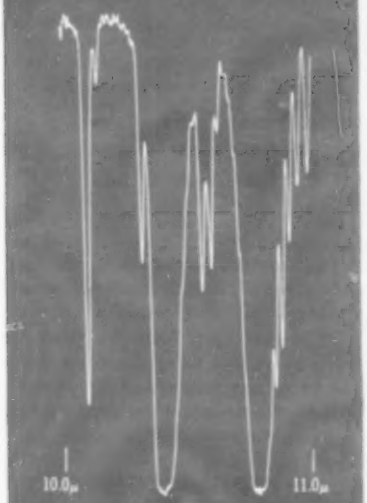
BECKMAN RESEARCH INFRARED SPECTROPHOTOMETER

For those who require the utmost in accuracy and resolving power, the Beckman Model IR-3 is the unquestioned choice. Experience has shown conclusively that the IR-3 outperforms all commercial instruments with respect to resolving power, photometric accuracy, wavelength accuracy, freedom from stray light and elimination of background absorptions.

Single-beam double-monochromator. Design perfection achieves very nearly theoretical resolution. Stray light is absolutely undetectable at 15 microns even with the exceptional one-tenth of one percent measuring sensitivity of the Beckman IR-3.

Background absorptions eliminated. The entire optical path of the IR-3 can be evacuated to completely eliminate background absorptions from water vapor and carbon dioxide. Liquid and gas cell compartments in both entrance and exit beams are separately sealed so that cells can be changed without affecting the vacuum in the rest of the system. All optical elements and samples are held at a constant temperature by means of circulating water and thermostat-controlled bath.

True transmittance recording through Memory Standardization. No cell matching. Wavelength accuracy, 5 mμ; wavelength precision, 1 mμ.



Unexcelled resolution is illustrated by this NH_3 spectrum made with sodium chloride prisms.

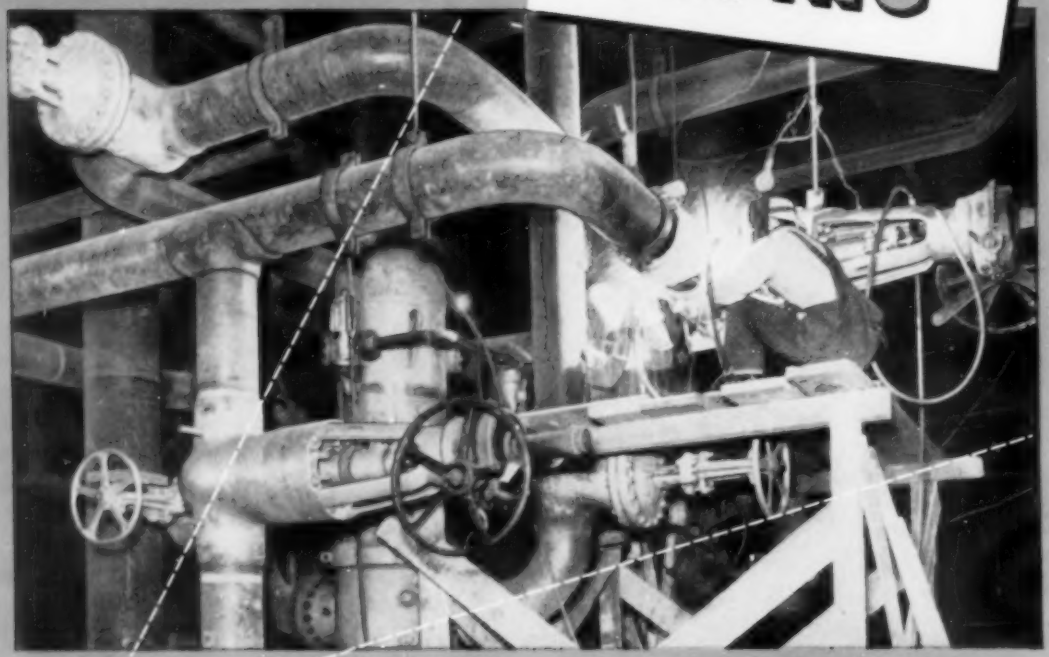
Select an instrument today that will do tomorrow's jobs. See your Beckman Field Representative about the superlative IR-3 or write for Data File 93-23

Beckman *division*

BECKMAN INSTRUMENTS, INC.
FULLERTON 1, CALIFORNIA

THERE IS

MUCH MORE TO MIDWEST PIPING



THAN MEETS THE EYE

Here you see carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

Then there is the experienced shop organization (working with the most modern equipment) that delivers to the field subassemblies which are accurate in dimension, correct in alignment, thoroughly cleaned, heat treated when necessary, carefully inspected and tested . . . ready for erection at lowest cost. Both the shop and field supervisory personnel have come up through the ranks and know every phase of the operations . . . how to assure the customer the most for his money when he buys Midwest Piping.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Mo.

PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

SALES OFFICES: NEW YORK 7—50 CHURCH ST. • BOSTON 27—426 FIRST ST. • LOS ANGELES 33—520 ANDERSON ST. • CHICAGO 3—79 WEST MONROE ST. • TULSA 3—224 WRIGHT BLDG. • HOUSTON 2—1213 CAPITOL AVE. • CLEVELAND 14—616 ST. CLAIR AVE.

6493

MIDWEST

PIPING FABRICATION and CONSTRUCTION

OFFERS YOU MANY BENEFITS

Chicago Site of Annual NACE Meeting

Eleven symposia will be offered by the National Association of Corrosion Engineers at its eleventh annual conference and exhibition, to be held this year at Chicago's Palmer House from March 7 to 11, 1955. The society also has scheduled a panel discussion on pipelines, a pipeline problem clinic and round table on pipeline and underground corrosion; a round table for general corrosion problems; three educational lectures, and a number of technical committee meetings.

In accord with custom, the annual business meeting of the society will lead off the conference on Tuesday, March 8. Monday will be devoted to committee meetings. After business has been transacted the technical program will open with a symposium on corrosion principles. T. P. May, International Nickel Co., and R. B. Hoxeng, United States Steel Corp., will lead the discussion.

A number of events of interest to refiners will be presented during the conference. A symposium on the refinery industry will be featured Monday afternoon, with F. M. Watkins, Sinclair Research Laboratories, and R. J. Hafsten, Standard Oil Co. (Ind.), as co-chairmen.

Among the offerings on Thursday will be a pipeline problem clinic and a symposium on protective coatings, which will run at the same time. The clinic will have as discussion leaders R. L. Bullock, Interstate Oil Pipe Line Co., and Lyle Sheppard, Shell Pipe Line Corp. W. B. Meyer, St. Louis Metallizing Co., will be chairman for the protective coating meeting.

Friday morning's sessions will include a general corrosion round table, having A. O. Fisher, Monsanto Chemical Co., and F. N. Alquist, Dow Chemical Co., serving as co-chairmen.

Maintenance Conference Jan. 24-26 in Chicago

A session devoted to maintenance in the process industries will be among the 37 events planned for this year's Plant Maintenance and Engineering Conference, to be held as usual at the International Amphitheatre in Chicago. In session from January 24 through 26, the conference will run concurrently with the Plant Maintenance and Engineering Show. Both events are in their sixth year.

Changes in conference hours, and use of the new exposition hall by the exhibitors, will permit visitors to attend both the show and conference during non-conflicting hours. General sessions of the conference will take place mornings in the arena of the Amphitheatre, directly adjoining the exhibits. The smaller sectional conferences and round-tables will be given in the evenings. Afternoons will be held free for the exhibits.

Each of five industries will have separate round-table sessions. These are the chemical industry, food, paper, steel and textiles. Among the topics to be dealt with in the sectional conferences are maintenance and construction of plant buildings, control of maintenance activities in the process industries by means of standardization and labor measurement, organization of the maintenance force, maintenance cost control, and preventive maintenance—what's good and what's bad about it.

Some of the round-table topics are as follows: maintenance of electronic control equipment, maintenance of electrical distribution equipment and lighting, corrosion control and prevention, lubrication, use of punched card systems in maintenance, maintaining power plant equipment, and project scheduling, estimating and control.

All round-tables, except the industry sessions, will be repeated on the following night to permit guests to attend two from this group.

Advance registration cards for both the show and conference may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17.

ACS Group to Discuss Hydrocarbon Chemistry

The symposium on hydrocarbon chemistry, sponsored by the American Chemical Society's Southeastern Texas Section, will be held in Houston, January 27 and 28, 1955, at the Rice Hotel.

On Thursday, January 27, the following papers will be read:

"Some Properties of Carbonium From Isotopic Tracer Experiments," by D. P. Stevenson, Shell Development Co.; "Rearrangements in Carbonium Ion-Type Reactions of Aliphatic and Alicyclic Derivatives," J. D. Roberts, California Institute of Technology; "Contributions of Modern Calorimetry to Chemical Thermodynamics," by Guy Waddington, Bartlesville Experiment Station, U. S. Bureau of Mines; and "Shock and Detonation Waves as a High Temperature Research Tool," by G. B. Kistiakowsky, Harvard University.

The program on Friday will include these papers:

"Methyl Affinities of Aromatics and Unsaturated Compounds," by M. Szwarc, College of Forestry, State University of New York; "Some Non-Classical Aromatics," by W. E. Doering, Yale University; "Free Radical Mechanisms of Hydrocarbon Reactions," by E. W. R. Steacie, National Research Council, Canada; and "Some Free Radical-Oxygen Reactions," by W. A. Noyes, Jr., University of Rochester.

API Sets Future Dates

The next annual meeting of the American Petroleum Institute will be held in San Francisco, Calif., Nov. 14-17, 1955. Meetings for the two years following have also been set: Chicago, Ill., Nov. 12-15, 1956, and again in Chicago, Nov. 11-14, 1957.

A date and location has also been scheduled for the 1956 mid-year meeting of the API Division of Refining: Montreal, Canada, May 14-17, at the Sheraton-Mount Royal Hotel.

Oil Man's Calendar

JANUARY

Society of Automotive Engineers, annual meeting, Hotel Statler, Sheraton-Cadillac Hotel, Detroit, Mich., January 10-14, 1955.

Plant Maintenance and Engineering Show, International Amphitheatre, Chicago, January 24 to 27, 1955.

Instrumentation for the Process Industries, Chemical Engineering Department of Texas A. & M. College, College Station, Texas, January 26-28, 1955.

Symposium on Hydrocarbon Chemistry, Southeastern Texas Section, American Chemical Society, Houston, Texas, January 27-28, 1955.

Fourth Annual Instrument Short Course, sponsored by the Southern California Meter Association, Los Angeles Harbor Junior College, Wilmington, Calif., January 27 and 28, 1955.

FEBRUARY

Natural Gasoline Assn. of America, Permian Basin regional meeting, Scharbauer Hotel, Midland, Texas, February 25.

MARCH

Chemical Institute of Canada, 5th divisional conference of the Chemical Engineering Division, Ottawa, Ont., March 7-9.

APRIL

American Society of Lubrication Engineers, 10th annual meeting and lubrication exhibit, Hotel Sherman, Chicago, April 13-15.

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL LUBRICATED PLUG VALVES

FIG. 3059G—300-Pound Steel Flanged End Valve. Sizes 6" to 12".

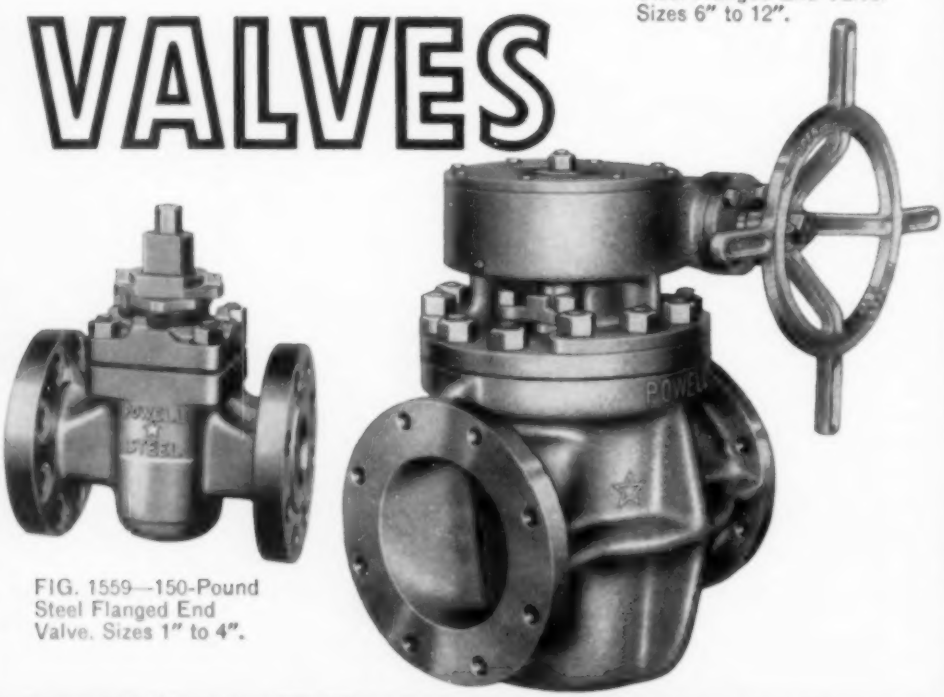


FIG. 1559—150-Pound Steel Flanged End Valve. Sizes 1" to 4".

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

Powell Valves—the *complete* quality line—offer many outstanding features in these new Lubricated Plug Valves, such as quick and sure operation and a positive seal when the valve is closed.

Valves are available with screwed or flanged ends; single, screwed and bolted gland types, and in Semi-Steel, Carbon Steel, Bronze, Ni-Resist, Monel Metal, and Stainless Steel. Semi-Steel valves are rated 175 and 200 pounds W.O.G.; Steel valves, 150 and 300 pounds W.P. Sizes from 1" to 12". Valves in sizes 6" and larger can be furnished with gears for gear operation. Distributors located in principal cities. For descriptive literature—or help on valve problems—write direct to

The Wm. Powell Company, Cincinnati 22, Ohio.....109TH year

Perry and Business Principles

Chemical Business Handbook, 1st ed., 1954, edited by John H. Perry with 124 contributors; 7½ x 10 in., 1323 pages, about 1000 illus., graphs, and tables; stiff cloth cover, $17. McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y.

JOHN H. PERRY, editor of the chemical engineer's "bible," *Chemical Engineers' Handbook*, long had planned a companion volume to aid "technical business men" in the chemical industry. He believed a firm understanding of business principles was necessary before the technical man could ascend the executive ladder of research, production, sales, accounting and other business specialties.

Though Dr. Perry died before his dream reached the publication stage, the work was carried on by others, and is now available as the *Chemical Business Handbook*. The Handbook is designed primarily for use by present and potential executives in the chemical industry as a basis of training, a reference source or a text book, but most of its sections should be equally applicable to other industries.

Organized in twenty basic business "Unit Operations" sections, *Chemical Business Handbook* covers the functions of business finance, management and control by cost accounting and planning, commercial chemical development, research, market research, market-research data and sources of information, industrial purchasing, production, traffic and transportation, sales, industrial advertising, credits and collections, personnel management, public relations, business law, patents and patent law, industrial toxicology, insurance and loss prevention, reports and report writing and business mathematics.

Where applicable, each section considers organization, methods, personnel, facilities and budgeting with a listing of specialized terminology peculiar to those functions. Generous use is made of drawings, forms, specific examples, tabulations, and information source references.

Chemical Business Handbook is a valuable addition for the personal library of every technical man desiring to obtain the business understanding necessary for a continued professional climb.

Papers of AIChE Meeting Published in Book Form

Chemical Engineering in Practice, edited by James I. Harper, 1954, 7½x5 in., 140 pp., stiff cloth cover, $3. Rheinhold Publishing Co., 330 W. 42nd St., New York 36, N. Y.

THE accent is on advice to the younger generation of engineers in the contributions to "Chemical Engineering in Practice," a small volume consisting of papers delivered at a meeting in 1953, of the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers. The essays are interrelated and organized to follow the development of a process plant from the first planning to execution and routine operation.

The first contributor is G. Alex Mills, Houdry Process Corp., who tells the part played by process research—a specialty on the borderline between chemical research and process development—in first perceiving the process' feasibility for commercial development. The process development department's job in transforming laboratory data into terms of plant operation is related by J. J. Hur, of the Atlantic Refining Co.

The process engineer, who elaborates the economic and mechanical features of the project in greater detail, is the topic of A. S. West, Rohm and Haas Co. Selecting from among the numerous projects a company usually has on tap the processes whose commercial development would be most profitable is the function of economic analysis, or "project evaluation." Some basic information about this phase is supplied by Edwin M. Ott, Pennsylvania Salt Manufacturing Co.

While the economic future of the project is being worked out by the economist the project engineer is giving the entire plan his careful scrutiny and is translating data developed at earlier stages into actual plans and specifications. Consideration of some of his special problems is given by W. F. Cooke, of the du Pont Co.

Putting the process plant up is obviously the task of the construction engineer, whose story is told by G. L. Eaton, of United Engineers and Constructors, Inc. The person charged with the continuing operation of the plant and with devising ways to increase its efficiency is the operating engineer. W. C. Huffman, of Sun Oil Co., offers some observations on the relationship of this office to the other technical departments during and after construction of the new plant.

The final chapter, on market research in chemical products, is provided by Dr. Richard E. Chaddock, of Hercules Powder Co. Helpful introductions to each chapter were written by James I. Harper, Sun Oil Co., who was program chairman at the Philadelphia-Wilmington Section meeting and editor of this published version.

Solvents and Plasticizers In Resin Formulating

The Technology of Solvents and Plasticizers, Arthur K. Doolittle, 6 x 9 in., xv + 1056 pages, stiff cloth binding, $18.50, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y.

THE release of hitherto confidential research data by Carbide and Carbon Chemicals Co., along with published data and the personal experience of the author and contributors, has made this book on the formulation of resinous compounds possible.

While solvents serve many purposes in the chemical industry, this book is concerned only with the characteristics making them useful processing agents for the paint, plastic, varnish, lacquer, adhesive, ink, synthetic textile, and related fields.

The author presents the scientific basis for deciding on appropriate formulations for specific purposes, emphasizing the behavior of systems over a range of variables. An attempt is made to present sufficient data to allow the reader to derive answers for specific formulation problems.

Included are detailed discussions of various formulations with their advantages and drawbacks, and the application, handling, storage, and transportation of raw materials and finished products. Another section is reserved for physical and chemical data of 161 solvents and 131 plasticizers used for resinous substances and commercially available in 1953. Experimental data dealing with multicomponent systems is in tabular and graphical form.

One chapter discusses synthetic textiles, and several theoretical chapters consider the thermodynamics of polymers, the viscosity of liquids, and the theory of solvent action.

Arthur K. Doolittle, Assistant Director of Research for Carbide and Carbon Chemicals Co., was temporarily relieved of a portion of his professional obligations in order to devote his time to this book.

Royalties from the sale of the book will be donated to the American Chemical Society for the advancement of the chemistry profession.

he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country – and world – penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine – the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it" – "they" being all the industry's front line of innovators and improvers–and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you – giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL PUBLICATIONS

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

ADDITIVES, lube oil, polymeric, samples on request; DuPont Co. See adv't. p. 90.

AIR COOLING equipment, two general types, equipment bulletin; Hudson Engineering Corp. See adv't. Second Cover.

ALLOY METALS, for corrosive service, available in many fabricated forms, literature; Ampco Metal, Inc. See adv't. p. 97.

BLENDING EQUIPMENT, automatic compounding, brochure SM-2055; Proportioneers, Inc. See adv't. p. 2.

BUBBLE CAPS and risers, many standard types and styles, catalog 54; The Pressed Steel Co. See adv't. p. 20.

CATALYST, for fluid cracking, "Aerocat", data sheet; American Cyanamid Co. See adv't. p. 119.

CHEMICAL CLEANING, for all refinery equipment, pamphlet; Dowell, Inc. See adv't. p. 13.

CLEANING, industrial, for drums and tanks, handbook on request; Oakite Products Co. See adv't. p. 125.

COMPRESSOR, gas engine driven, various horsepower, bulletin 75; Cooper-Bessemer Corp. See adv't. p. 73.

EXPANSION JOINTS, slip-type, bulletin EJ-1913; Yarnall-Waring Co. See adv't. p. 31.

FILTERS, for catalyst, to replace cyclones and electrostatic precipitators, literature; Micro Metallic Corp. See adv't. p. 130.

FLANGES, drop forged, wide range of sizes and styles, brochure; Phoenix Mfg. Co. See adv't. p. 130.

FLOATING ROOFS, double pontoon, manual WP-14; Gen'l. Amer. Trans. Corp. See adv't. p. 4.

FLOOR MAINTENANCE, polishers and scrubbers, explosion-proof, information; Lincoln-Schlueter Floor Mach. Co. See adv't. p. 129.

FLUID MIXERS, many types and sizes, catalogs available; Eastern Industries, Inc. See adv't. p. 113.

FRANGIBLE DISCS, for pressure protection, data sheet file; Frangible Discs, Inc. See adv't. p. 130.

GASKETS, "Teflon", non corrosive, many types, catalog TG-953; U. S. Gasket Co. See adv't. p. 121.

HEAT EXCHANGERS, scraped surface, bulletin PE-1; Henry Vogt Machine Co. See adv't. p. 120.

INSULATION, pipe, one-piece, bulletin; Baldwin-Hill Co. See adv't. p. 134.

MIXERS, side and top entering, various types and sizes, 9 catalogs available; Mixing Equipment Co. See adv't. p. 42.

PLANT DESIGN and construction, brochure 103; Kaiser Engineers. See adv't. p. 98.

PRESSURE CONTROL, automatic, Cartesian Manostats, bulletin; The Emil Greiner Co. See adv't. p. 133.

PRESSURE TRANSMITTER, shiftable range, bulletin 98097; Taylor Instrument Cos. See adv't. pp. 28-29.

PUMPS, stuffingboxless, high pressure, bulletin 107; Bingham Pump Co. See adv't. p. 14.

REFRACTORY LINING, hydraulic setting, brochure RC-28A on "Blazecrete" and "Firecrete"; Johns-Manville Co. See adv't. p. 137.

SPECTROPHOTOMETER, for infrared measurement, data file 93-23; Beckman Instruments, Inc. See adv't. p. 101.

TANK GAUGE, electronic, brochure, Gilbert & Barker Mfg. Co. See adv't. p. 24.

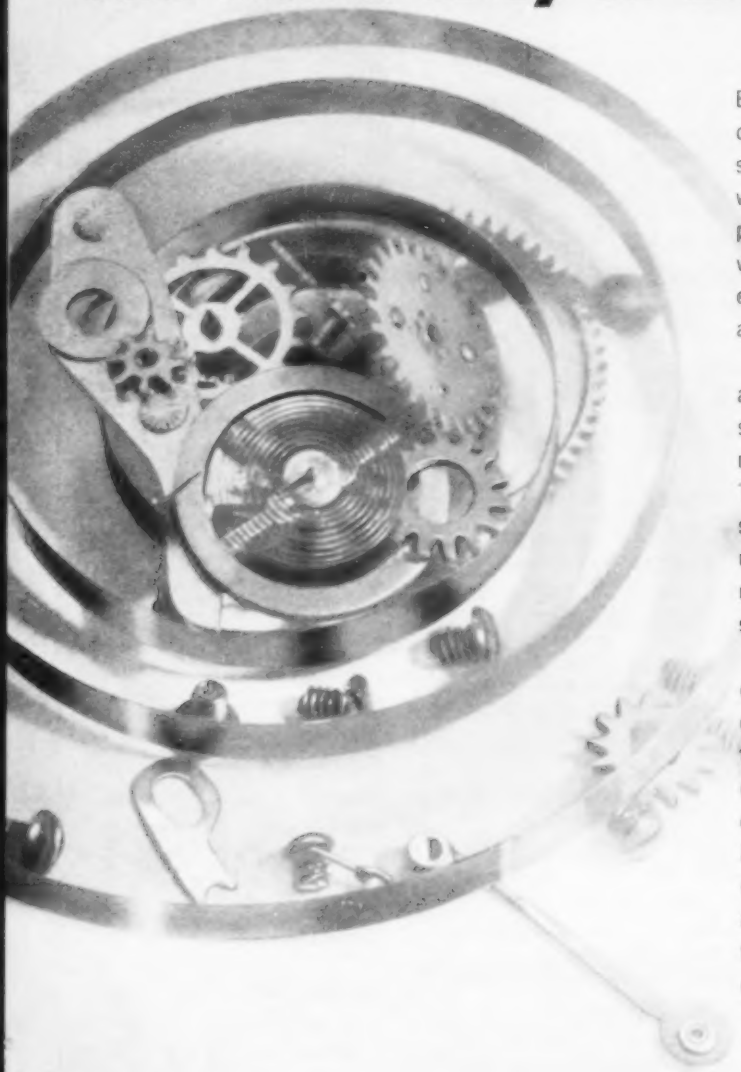
TEMPERATURE MEASUREMENTS, electronic potentiometer, recording type, bulletin 427-1; Foxboro Co. See adv't. p. 135.

TUBE FITTINGS, "Swagelok", from metal or plastic, catalog; Crawford Fitting Co. See adv't. p. 93.

VALVES, lubricated plug, catalog; Homestead Valve Mfg. Co. See adv't. p. 122.

VALVES, steel plug, non-lubricated, catalog; Wedgeplug Valve Co., Inc. See adv't. p. 124.

The Hard Way to Buy a Refinery



Buying a petroleum refinery in "pieces" from different sources, each with its own design standards and materials specifications, is somewhat like buying a watch the same way. An expert can put the units together and make them work. But it's a lot simpler, and usually more economical, to buy the complete "package"—assembled and already running when you get it.

When planning a new refinery, or modernizing an existing one, there are many economic reasons why it pays to have a single contractor responsible for integration of the entire project. These include centralized purchasing power; shorter and flexible construction schedules; uniformity of design factors in process equipment; and the elimination of duplicate construction managers and their staffs.

The M. W. Kellogg Company, world's leading designer and builder of petroleum refineries, offers a complete "packaged-plant" contract to the petroleum and petro-chemical industries. It covers process engineering; plant design and construction of the entire job, including off-site installations such as tanks, loading facilities, docks, roads; supervision until on stream; and a production guarantee. We welcome the opportunity to discuss with you the many advantages of The M. W. Kellogg "packaged-plant" contract.

M.W. Kellogg

ENGINEERING FOR TOMORROW

THE M. W. KELLOGG COMPANY, NEW YORK 7, N. Y.

The Canadian Kellogg Company, Limited, Toronto • Kellogg International Corporation, London.

SUBSIDIARIES OF PULLMAN INCORPORATED

ADVERTISERS' INDEX

This index is published as a convenience to the reader. Every care is taken to make it accurate, but PETROLEUM PROCESSING assumes no responsibility for errors or omissions.

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

Circle the code letter on the "advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

(A-1) Aerotol Mfg. Co. 118
(A-2) Air Preheater Corp. 132
(A-3) Alamask Div., Rhodia, Inc. 126
(A-4) American Cyanamid Co., Refinery Chemicals Dept. 119
(A-5) Ampco Metal, Inc. 97
(A-6) Anaconda Copper Mining Co. 128
(A-7) Baldwin-Hill Co. 134
(A-8) Barrett Mfg. Co. 129
(A-9) Beckman Instruments, Inc. 101

(B-1) Bethlehem Steel Corp. 115
(B-2) Bingham Pump Co. 14
(B-3) Black, Sivalls & Bryson, Inc. 21
(B-4) Chicago Bridge & Iron Co. 16
(B-5) Cooper-Bessemer Corp. 73
(B-6) Crane Co. 78
(B-7) Crawford Fitting Co. 93
(B-8) Dowell, Inc. 13
(B-9) Dresser Industries, Inc. 18-19

(C-1) DuPont de Nemours & Co., Inc. 90
(C-2) Eastern Industries, Inc. 111
(C-3) Enjay Co. 1
Ethyl Corp. 74-75
(C-4) Foster Wheeler Corp. 11
(C-5) Foxboro Co. 135
(C-6) Frangible Discs, Inc. 130
(C-7) Gen'l. Amer. Trans. Corp., Plate & Welding Div. 4
(C-8) Gen'l. Amer. Trans. Corp., Terminals Div. 6
(C-9) Gen'l. Chemical Div., Allied Chem. & Dye Corp. ..... Cover 3

(D-1) Gilbert & Barker Mfg. Co. 24
(D-2) Graver Tank & Mfg. Co., Inc. 10
(D-3) Greiner Co., The Emil 131
(D-4) Harshaw Chemical Co. 116
(D-5) Hercules Powder Co. 17
(D-6) Homestead Valve Mfg. Co. 122
(D-7) Hudson Engineering Corp. ..... Cover 2
(D-8) International Nickel Co. 123
(D-9) Johns-Manville Corp. 117

(E-1) Kaiser Engineers 98
(E-2) Kellogg Co., The M. W., Contract Sales Div. 107
(E-3) Key Co. 94
(E-4) Koch Engineering Co. 111
(E-5) Kullian Corp. 117
(E-6) Lincoln-Schlueter Floor Mach. Co. 129
(E-7) Lukens Steel Co. 30
(E-8) Lummus Co. 9
(E-9) McKee & Co., Arthur G. 36

(F-1) Micro Metallic Corp. 130
(F-2) Midwest Piping Co. 102
(F-3) Mixing Equipment Co. 42
(F-4) National Alumonite Corp. 25
(F-5) Norton Co. 112
(F-6) Oakite Products Co. 125
(F-7) Orbit Valve Co. 26
(F-8) Oronite Chemical Co. 15
(F-9) Owens-Corning Fiberglas Corp. 89

(G-1) Pfaudler Co., The 78
(G-2) Phoenix Mfg. Co. 130
(G-3) Powell Co., The Wm. 104
(I-5) Precision Thermometer & Inst. Co. 129
(G-4) Pressed Steel Co. 20
(G-5) Procon, Inc. 127
(G-6) Proportioneers, Inc. Div. of B-I-F Ind. 2
(G-7) Refinery Engineering Co. 86
(G-8) Ridge Tool Co. 114
(G-9) St. Mary Iron Works 133

(H-1) Smith Corp., A. O. 14-15
(H-2) Taylor Instrument Cos. 28-29
(H-3) U. S. Gasket Co. 121
(H-4) Universal Oil Products Co. 22-23
(H-5) Vogt Machine Co., Henry 120
(H-6) Warren Petroleum Corp. 27
(H-7) Wedgeplug Valve Co. 124
(H-8) Western Supply Co. 32
(H-9) Wolverine Tube, Div. Calumet & Hecla, Inc. 36A-36B
(I-1) Worthington Corp. 116
(I-2) Wyatt Metal & Boiler Works Cover 4
(I-3) Yarnall-Waring Co. 31
(I-4) Zallea Brothers 41

SAVE TIME • SAVE EFFORT • KEEP INFORMED

USE THIS CARD . . .

to secure information on products and services advertised in *Petroleum Processing* or reviewed in its *"What's New"* section.

FOR ADVERTISED PRODUCT INFORMATION:
Check the Advertiser's Index for advertisement's code letter. Then circle the corresponding code letter on the card below.

FOR "WHAT'S NEW" PRODUCT INFORMATION:
Circle the code number on the card below which corresponds to the number listed at the end of that specific "What's New" item.

THEN:
Fill in your name, position, company and mailing address. Mail the card . . . no postage is required.

PETROLEUM PROCESSING READER SERVICE INFORMATION CARD—VOID AFTER **APRIL 15, 1955**

"WHAT'S NEW" ITEMS

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64
65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80

ADVERTISED PRODUCTS

A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	K1	L1	M1	N1	O1	P1
A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	K2	L2	M2	N2	O2	P2
A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	K3	L3	M3	N3	O3	P3
A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	K4	L4	M4	N4	O4	P4
A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	K5	L5	M5	N5	O5	P5
A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	K6	L6	M6	N6	O6	P6
A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	K7	L7	M7	N7	O7	P7
A8	B8	C8	D8	E8	F8	G8	H8	I8	J8	K8	L8	M8	N8	O8	P8
A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	K9	L9	M9	N9	O9	P9

PETROLEUM PROCESSING
A McGRAW-HILL PUBLICATION

1/55

Name (Please Print) _____ Position _____

Company _____ Business Address _____

City, Zone _____ State _____

PETROLEUM PROCESSING READER SERVICE INFORMATION CARD—VOID AFTER **APRIL 15, 1955**

"WHAT'S NEW" ITEMS

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64
65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80

ADVERTISED PRODUCTS

A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	K1	L1	M1	N1	O1	P1
A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	K2	L2	M2	N2	O2	P2
A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	K3	L3	M3	N3	O3	P3
A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	K4	L4	M4	N4	O4	P4
A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	K5	L5	M5	N5	O5	P5
A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	K6	L6	M6	N6	O6	P6
A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	K7	L7	M7	N7	O7	P7
A8	B8	C8	D8	E8	F8	G8	H8	I8	J8	K8	L8	M8	N8	O8	P8
A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	K9	L9	M9	N9	O9	P9

PETROLEUM PROCESSING
A McGRAW-HILL PUBLICATION

1/55

Name (Please Print) _____ Position _____

Company _____ Business Address _____

City, Zone _____ State _____

FOR MORE INFORMATION...

about products and services advertised in this issue of Petroleum Processing or reviewed in its "What's New" section, use the postage-free cards provided below.
(See other side for complete instructions.)

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P. L. & R.)
New York, N. Y.

BUSINESS REPLY CARD
No Postage Necessary if Mailed in the United States

4c-POSTAGE WILL BE PAID BY

PETROLEUM PROCESSING

330 WEST 42nd STREET

NEW YORK 36, N. Y.

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P. L. & R.)
New York, N. Y.

BUSINESS REPLY CARD
No Postage Necessary if Mailed in the United States

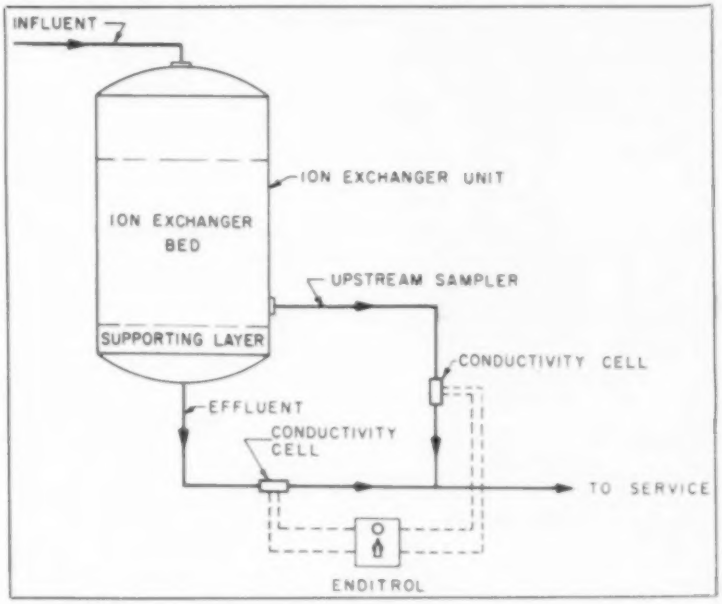
4c-POSTAGE WILL BE PAID BY

PETROLEUM PROCESSING

330 WEST 42nd STREET

NEW YORK 36, N. Y.

WHAT'S NEW...



Endpoint Indicator for Ion Exchange

Up to today there has been no suitable automatic device to indicate the end of the operating run of a hydrogen cation exchanger unit. The new electronic control "Enditrol" operates on the principle that as the downflow hydrogen zeolite ion exchanger approaches exhaustion, the hydrogen concentration of the effluent has a higher conductivity than that of the upstream sample. Equipped with proper electrical controls, this device can also be used for automatically initiating the operation of automatic exchanger regeneration equipment. Alarm bells or lights can be incorporated with Enditrol by relay to signal the end of an operating run. The Permutit Co., 330 W. 42nd St., New York 36, N. Y.

Circle No. **17** *on Reply Card*

Two-Wire Thermocouple Has Stainless Case for Longer Life

. . . and has a rated accuracy of ±5° F. over a range from 0° F. to 1000° F. The stainless steel protecting tube is expected to double the life of the thermocouples. Two types of terminal heads are available, the open head assembly or the screw-cover head. Fiberglass insulation permits greater application flexibility than possible with ceramic-insulated pencil-type models. Thermocouple lengths range from 6 in. to 60 in., with 35 ft. lengths available on a special basis. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Philadelphia, Penna.

Circle No. **18** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.

Plant Scale Models Are Made Quickly by "Erector Set" Kit

. . . from which a series of photographs can be obtained giving the equivalent to design engineer's or draftsman's construction plans. The "PDQ" kit includes plastic and wood models accurately scaled to drawing size, especially suited for the chemical and petro-chemical industries. Model construction can be accomplished directly by the engineer from his flow sheet or plot plan. It is claimed that this method requires but a fraction of the time and cost required for conventional methods, eliminates the need for model makers, and allows more secrecy for the using company. The Parco Co., Inc., 82 Beaver St., New York 5, N. Y.

Circle No. **19** *on Reply Card*

New Gate Valve Line Blind Eliminates Lifting of Plates

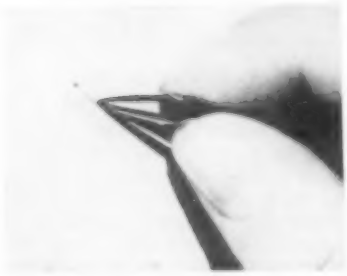
. . . and has no bolts to loosen. Operating on the gate valve principle, the rising stem raises the blind plate from the valve body into line with a machined carrier track incorporated in the top of the valve yoke. The blind plate slides off the stem on to the carrier track, and another blind or spectacle plate is slid on to the valve stem and lowered into position. The "OS & Y" gate valve line blind is claimed to afford as positive an action as a shut-off blind. Available in larger sizes where lifting heavy plates is a problem, the valve employs standard "O" ring secondary seals in the wedges. Vernon Tool Co., Ltd., 1101 Meridian Ave., Alhambra, Calif.

Circle No. **20** *on Reply Card*

All-Molded Plastic Valves Are Strong, Corrosion-Resistant

. . . and are claimed to be the first "all-molded" valves made. "Luncor" valves and fittings resist most chemicals used in industry. The molding process affords greater physical strength and corrosion resistance, and reduces manufacturing costs to allow PVC (polyvinylchloride) valves to be marketed at a price lower than stainless steel and other alloy valves. The PVC is molded in rigid form, suitable for pressures up to 125 psi and 150° F. Valves presently available are of Y-type globe design. Fittings of the same material include caps, couplings, plugs, unions, reducing bushings, flanges, 45-degree and 90-degree elbows, and tees. The Lunkenheimer Co., Cincinnati 14, Ohio.

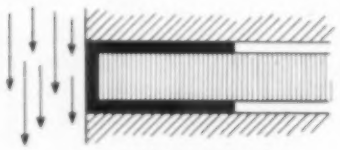
Circle No. **21** *on Reply Card*



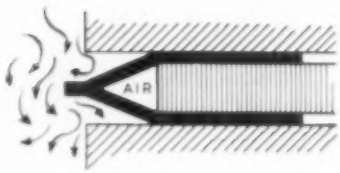
New Small Thermistor Has High Speed Response

. . . for continuous use up to 300° C., and is useful even to 400° C. with good stability. The "TCA type I. 118" thermistor is a glass-coated ceramic element less than 18 thousandths of an inch in diameter with 1 mil diameter platinum alloy leads. The thermal time constant of this sensing unit is one second in still air, and less in liquids. One milliwatt of electrical power will heat the thermistor more than 10° C. above the ambient temperature in still air. Due to these properties, the manufacturer recommends their use for liquid level detection devices. About 10 thermistors can be placed on the head of a common pin without stacking. Thermistor Corp. of America, Metuchen, N. J.

Circle No. **22** *on Reply Card*



FreeFlow Construction



Ordinary Construction

Rupture-Proof Teflon Gaskets Eliminate Line Turbulence

. . . due to channel construction so that it does not extend beyond the I. D. of the pipe to cause a throttling action. The "FreeFlow" is also said to eliminate danger of gasket rupture at high temperature due to entrapped air between insert and envelope. Construction of the gasket also assures full contact with the pipe flanges, and allows the insert to extend to the full depth of the gasket envelope to eliminate air space. The envelope is made of DuPont Teflon for corrosion resistance and service from −100° F. to +482° F., depending upon the insert material. FreeFlow is available in all shapes and sizes. Crane Packing Co., Dept., PPN, 1800 Cuyler Ave., Chicago 13, Ill.

Circle No. **23** *on Reply Card*

New Nickel Catalyst Increases Ammonia Synthesis Gas Yields

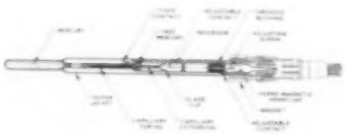
. . . by a claimed 25% without sacrificing product quality. "G-29" catalyst also allows the alternate of operating at the same rates and reducing the reaction temperature by 100° F., thus reducing process fuel costs. The catalyst contains about 27% nickel which becomes active in reforming hydrocarbons at temperatures of 1100° F. to 1850° F. It can be employed in the production of ammonia synthesis gases, controlled atmospheres and carrier and fuel gas, and for the dissociation of ammonia. Preshrinking limits catalyst shrinkage to less than 5% below 1850° F. Available in ½ in. or ¾ in. extrusions with an apparent gross density of 84 and 80 lb./cu. ft., it is also supplied as ¾ in. rings. The Girdler Co., 224 E. Broadway, Louisville 1, Ky.

Circle No. **24** *on Reply Card*

New Coating Protects Propane Tanks from Fire or Weather

. . . by a mastic-asbestos-mastic combination. The method was tested with naked gas flames on small scale tanks, and exceeded the requirements of the Associated Factory Mutual Insurance Cos. and the National Board of Fire Underwriters. The coating consists of a 1/16-in. base coat of Palladium type T or T2 Mastic, followed by a 15/8-in. layer of asbestos and ceramic material supported by wire mesh, and finally an additional 1/8-in. overcoat of T or T2 Mastic with or without an optional glass fibre membrane. A coat of aluminum paint may be applied for appearance and reflecting radiant heat. Emjay Maintenance Engineers, 327 Union Ave., Rutherford, N. J.

Circle No. **25** *on Reply Card*



New Mercurial Thermoregulator Can Control Within 0.005° C.

. . . and is said to control within ±0.002° C. under favorable conditions. The "Magna-Set" operates within a range of −35° C. to +300° C. For lower temperatures the "Mercuthal Magna-Set" which uses a mercury-thallium alloy operates from −60° C. to −35° C. Operation is by making a rough preliminary adjustment using the displaced mercury reservoir and a typical heating and cooling process. Fine adjustment to the exact operating temperature then is made by twisting the magnetic control, causing an armature to rotate through a micrometer controlling the position of a variable electrode. Contact is made or broken by the electrode for control of the operating temperature. Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.

Circle No. **26** *on Reply Card*

Is pressure drop your problem?

As simple as 2 plus 2—when you can recover 85% to 92% of the slot energy as mixing energy, you'll find your pressure drop problems are solved . . . and only Benturi Kaskade trays will give you this amount of recovery when and where you want it.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS · MANUFACTURERS · BUILDERS

321 WEST DOUGLAS — WICHITA 2, KANSAS

REPRESENTATIVES

Eastern and Export
30 Rockefeller Plaza
New York City

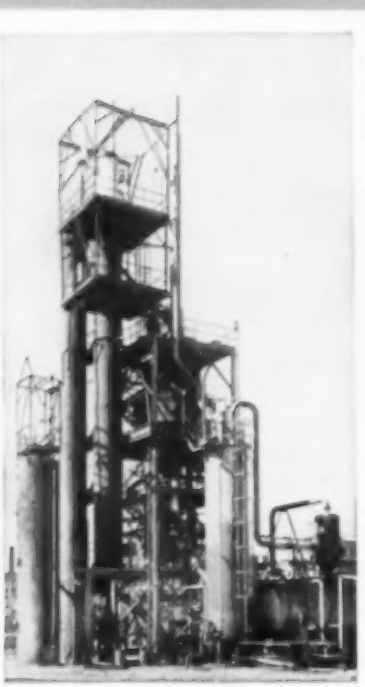
Pittsburgh, Pa., Repr.
D. D. Foster Co.
714 Frick Bldg.

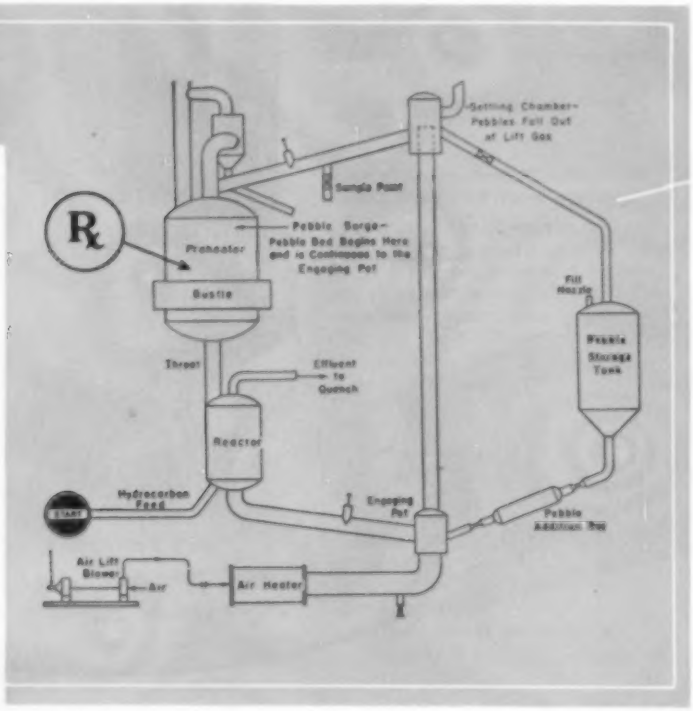
Tulsa, Okla., Repr.
Myers-Bogwell Co.
Wright Bldg.

Koch International
10 Rue Auber
Paris, France

Rx for cost-saving efficiency

in high temperature processing . . .





Pebble Heater in which ALUNDUM heat exchange pebbles have proved ideal as a heat transfer medium. Flow diagram shows how the continuous pebble bed moves from the engaging pot through reactor, preheater and chambers at a rate governed by a control device in the engaging pot. Heat is supplied by hot gases generated in the bustle-type combustion chamber. (Diagram courtesy of *Petroleum Refiner.*)

Pebble heaters with ALUNDUM* pebbles

Pebble heaters are now available which are capable of heating gases above operating temperatures permissible in conventional tube furnaces. Low initial cost, high operating efficiency and the use of low cost gas or oil fuel are attracting favorable attention to these heaters for high temperature processing.

For the production of ethylene, for example, the Phillips Petroleum Company has installed a 30 Mm Btu per hour commercial pebble heater at Borger, Texas, following several years of successful pilot plant operation.

In this installation, Norton ALUNDUM heat exchange pebbles have given excellent results. ALUNDUM pebbles, *engineered* to stand up under abrasion, impact and repeated heating and cooling, are *prescribed* as the ideal heat transfer medium for pebble heaters. Also, their high refractoriness, which prevents softening or incipient fusion at any point in the pebble heater's upper bed, keeps them from "bridging" together and causing stoppages in the moving bed.

Rx's for YOUR refractory needs

are included in the broad Norton line of *engineered and prescribed* refractories. For information concerning ALUNDUM heat exchange pebbles or other Norton refractories, or for expert technical aid, call in your Norton Refractories Engineer. Or write to NORTON COMPANY, Refractories Division, 260 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

NORTON

REFRACTORIES

Engineered . . . Rx . . . Prescribed

Making better products . . . to make other products better

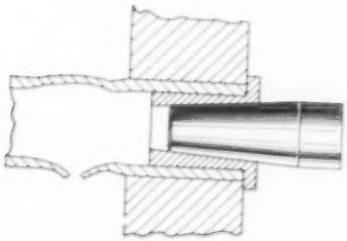
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

(To obtain more data on advertised products see page 108)

New Three-Way Air Line Valve Has Toggle Switch Control

. . . for straight through flow, or vent to the atmosphere while the valve inlet is shut off. Currently used on air pressure lines having 200 psi pressure, they have been tested up to 500 psi. The "Demi" valve is available in bronze, aluminum, steel, or stainless steel body with a neoprene diaphragm in all cases. The bonnets can be furnished as shown in the picture, or threaded for panel mounting. The outside diameter is 1½ in. and the overall height is about 2 in. George W. Dahl Co., Inc., 430 High St., Bristol, R. I.

Circle No. **27** *on Reply Card*



Plug Seals Off Leaky Condenser Or Heat Exchanger Tubes

. . . and consists of a close fitting brass bushing with a collar, and a tapered steel plug which expands the bushing when driven into place. The expanded bushing or sleeve makes a tight fit without damage to the tube sheet. Bushing expansion is parallel giving complete contact with the tube surface. Tube inside diameter at the expanded section must be specified. Lagonda Div., Elliott Co., Springfield, Ohio.

Circle No. **28** *on Reply Card*

SOLVE YOUR MIXING PROBLEMS

A tremendous variety of fluid mixing needs are ably handled by the complete line of Eastern Mixers. Size and power of mixers are flexible to help solve your problems. For complete information and engineering data, write for Eastern Fluid Mixing Catalogs. Eastern engineers are always available to work out your complex mixing problems with you.

EASTERN INDUSTRIES ★ MIXER DIVISION ★

Eastern INDUSTRIES, INC.

Dept. F, Regent St., Norwalk, Conn.

Why

do most users

prefer and buy the genuine

RIDGID

PIPE WRENCH?

It's easiest to work with . . . perfect balance . . . comfort-grip I-beam handle . . . handy pipe scale on hookjaw . . . easy-spinning adjusting nut . . . clean grip on pipe, no slip or lock.

It lasts longer . . . first guaranteed housing, won't break or bind . . . ever. Every wrench individually tested before shipment . . . and millions of them in use. Sizes 6" to 60"—end pattern, 6" to 36".

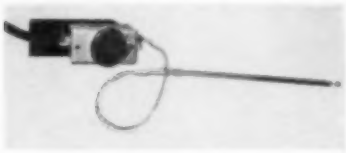
For the most for your money, buy RIDGID . . . Your local Supply House stocks them for you, delivers them fast!

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

RIDGID

Work-Saver Pipe Tools

What's New!



Sensitive Quartz Thermostat Resists Chemical Attack

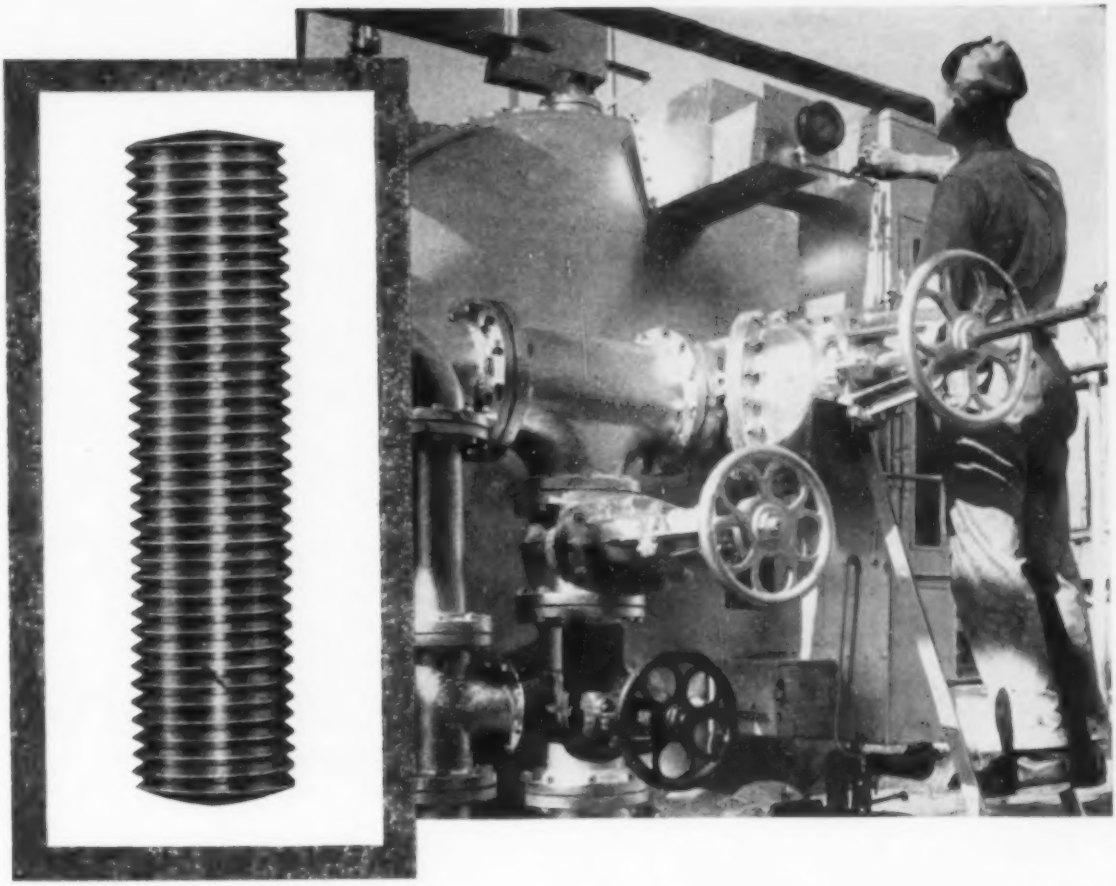
. . . and provides high capacity in limited space. Construction includes the chemically resistant quartz tube containing a liquid which actuates a contact mechanism by expansion and contraction resulting from temperature changes. The "Thermex" thermostat is rated at 5000 watts at 120 to 240 volts. Operating temperature range is adjusted by a dial. Tube lengths are available from 6 in. to 36 in. N. J. Thermex Co., Inc., 533 Bergen St., Harrison, N. J.

Circle No. **29** *on Reply Card*

Removable Rubber Inserts Made For 55 Gallon Drum Lining

. . . are preformed of neoprene or sheet rubber. "Drumserts" can be used with any standard drum. The rubber insert is set in the drum and the insert "lip" is lapped over the top of the drum and pulled taut so that the insert maintains a stationary position regardless of handling. Use of the insert allows any standard 55 gallon drum or barrel to be used with acids and other corrosive liquids. Removal of the rubber inserts is easily accomplished by peeling the "lip" that laps over the sides of the drum. Rubber "snap-on" lids are also furnished for use with the rubber inserts. Automotive Rubber Co., Inc., 12550 Beech Road at P.M.R.R., Detroit 39, Mich.

Circle No. **30** *on Reply Card*



Continuous-Thread Stud Minimizes Down-Time in High-Temperature Bolting

To be sure of economy in high-temperature, high-pressure bolting applications, you need a stud with plenty of stamina at the operating temperatures . . . one that minimizes down-time for long periods of time. That's why it pays to use Bethlehem's continuous-thread stud.

The Bethlehem Continuous-Thread Stud is economical for high-temperature, high-pressure bolting because it does such an effective job of minimizing stress concentrations. The stud has no point of thread runout. Consequently, when stresses do occur, they can't concentrate at any one point to cause early failure, but instead are effectively distributed over the stud's full working length.

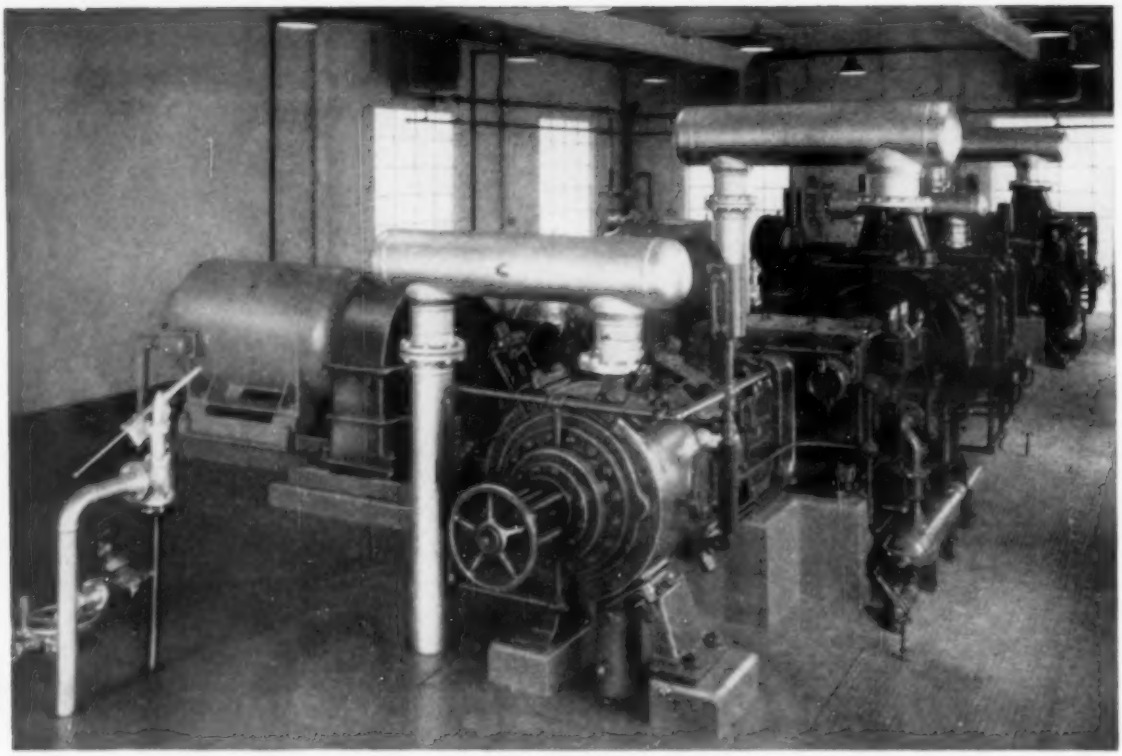
The Bethlehem Continuous-Thread Stud is made of alloy steel, and is furnished heat-treated. It meets the requirements of ASTM Specification A-193, and comes in a wide range of sizes, many of which are carried in stock.

The nearest Bethlehem office is always ready to answer your questions about heat-treated alloy studs for difficult bolting applications. Or write direct to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

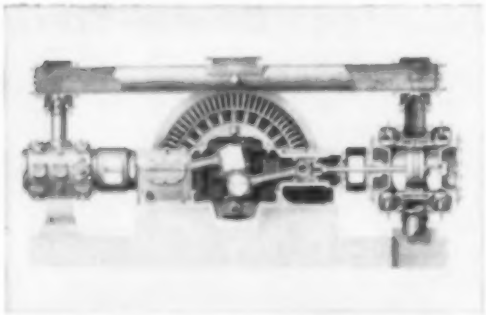
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Bethlehem Bolts and Nuts ★ BETHLEHEM STEEL ★



LINEUP OF WORTHINGTON 2-cylinder gas compressors at Frontier Oil's new Tonawanda (N.Y.) refinery. Units are rated at 600 hp each.

Frontier's new refinery gets Worthington compressors



CUTAWAY VIEW of Worthington balanced-opposed compressor. Note low silhouette, modest foundation requirements, and double-throw crankshaft which permits as many as four pairs of cylinders to be arranged on single compressor frame.

At Frontier Oil Refining Company's big new refinery in Tonawanda, N.Y., two Worthington type BDC-2 balanced-opposed gas compressors have gone to work in the two stage compression of hydro-carbon gas mixtures. By selecting Worthington units, Frontier made sure of:

Smooth, vibrationless operation. Two throw crankshaft with cranks set at 180 degrees gives opposed piston action.

Low-cost installation. Packaged design provides quick and easy field assembly. Lack of vibration permits location on small foundation.

In chemical plants and general industrial installations, these Worthington units are paying off in dependable operation. You can use practically any type of drive to power them. Like all Worthington compressors, they are equipped with the exclusive Feather* Valve — lightest, tightest, most efficient valve made.

Remember, no matter what your capacity or pressure requirements may be, there's a compact Worthington steam- or motor-driven compressor to fill the bill. Write Worthington Corporation, Compressor Division, Section K.3.5, Buffalo, N.Y. K3.5

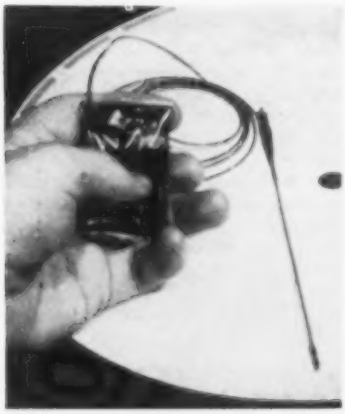
* *Reg. U.S. Pat. Off.*

"SEE the Worthington Corporation Exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 41st Street."

WORTHINGTON

Only Worthington Compressors give you Feather Valve Performance

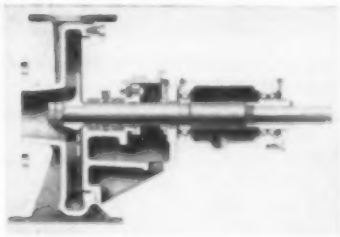
Y-Types • Balanced Angle • Balanced-Opposed • Direct Connected • Gas Engine



New Instrument Recording Pen Has a Year's Supply of Ink

. . . fed from a clear, hermetically-sealed, plastic ink sac. Capillary action maintains continuous flow to a precision ground point which traces an opaque, quick-drying record. As many as four pens can trace on parallel time arcs only forty-two thousandths of an inch apart, simplifying record interpretation. The ink supply is contamination proof, non-corrosive, non-evaporating and will not develop sludge or oxide due to being sealed. Pens have been tested on equivalent accelerated 15-year tests from 20° F. to 140° F. without damage. The system is designed for exclusive use in the Bailey Recorder. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.

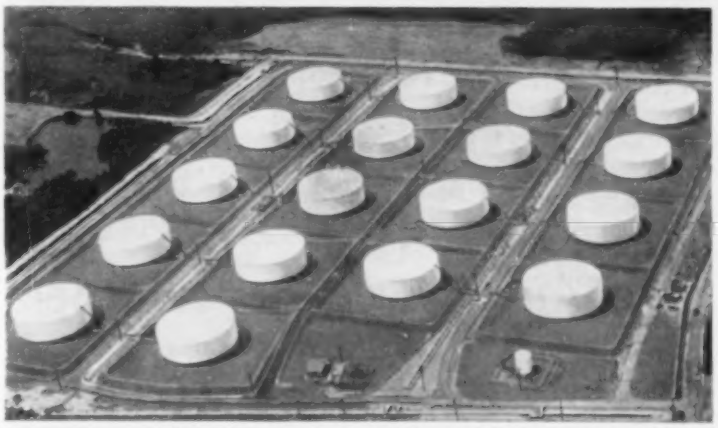
Circle No. **31** *on Reply Card*



Centrifugal Chemical Pump Is Simple to Inspect and Repair

. . . since the complete pump rotating element, bracket and stuffing box assembly can be removed as a unit without disturbing the suction or discharge piping. Engineered for acids and other corrosives, "BJ Chemical Pumps" are available in four basic sizes with various motor and impeller combinations to cover a capacity range from 20 to 400 gpm. All pump parts are interchangeable except the pump case and impeller. Corrosion protective features

ESSO BREAKS A RECORD
. . . Automatically



ESSO STANDARD OIL COMPANY has been operating a semi-automatic loading and unloading system that is capable of pumping a record-breaking 100,000 barrels of heating oil or gasoline every five hours between the Bayway Refinery and the new Rahway River Tank Field in Linden, New Jersey, approximately four miles away.

The project consisted of 18 seasonal storage tanks, each having a capacity of 150,000 barrels; a giant 30-inch above ground pipeline which stretches over two and a half miles; a network of thousands of feet of smaller inter-connecting pipeline; and a centralized control house that permits loading and unloading operations to be carried out through the use of a push-button instrument panel. Other facilities included a 5000 barrel capacity comingled products tank, pumps, and 4 product-shipping pumps. With the exception of tankage, the project was designed, engineered, and constructed by The Kuljian Corporation.

The pipeline, control system, and tank field are now a functional monument to teamwork and production in the petroleum industry.

This same high level planning with which Kuljian serves the petroleum field . . . from preliminary design to production . . . can be made available to you wherever and whenever your plant requires expansion, modernization, or complete replacement. Experienced Kuljian engineers are prepared to discuss your requirements to assure the success of your next project. Why not call or write us today?

The Kuljian Corporation

engineers • constructors

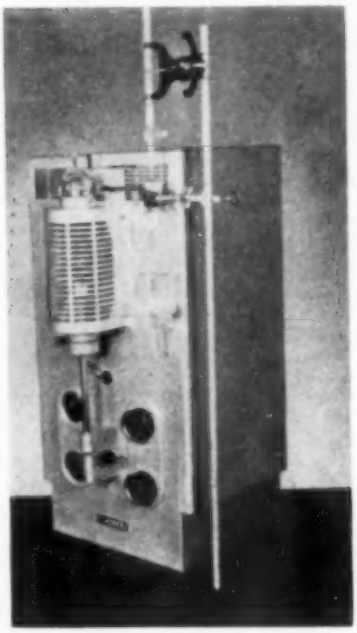
1200 North Broad Street • Philadelphia 21, Penna.

MEXICO CITY • CARACAS • BOGOTA • MADRID • ATHENS • BEIRUT • TOKYO • CALCUTTA • RANGOON

 (To obtain more data on advertised products see page 108)

include a corrosion resistant catch basin integral with the pump case, molded synthetic rubber snap-on gland cover to guard against acid spray, and synthetic rubber deflector and stainless steel labyrinth to guard against acid and acid fumes entering the bearings and grease lubrication. Materials of construction include a choice of Alloy 20 or cast iron. Byron Jackson Co., Pump Div., P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

Circle No. **32** *on Reply Card*



Sulfur in Petroleum Is Analyzed Rapidly with Combustion Unit

. . . having a high frequency induction furnace. All samples covered by ASTM Bomb or Lamp methods can be completely burned by the unit and show good agreement with these methods. One complete analysis requires 15 to 20 minutes from initial weighing to final computation. Operation includes placing the weighed sample in the induction field, after which the operator devotes his attention to titrating—Iodometric Method—the combustion gases which pass through an acid solution of starch, potassium iodide, and a few drops of potassium iodate. The furnace generates temperatures in excess of 3000° F., bringing the sample to incandescence in a few seconds. Lindberg Laboratory Div., 2450 W. Hubbard St., Chicago 12, Ill.

Circle No. **33** *on Reply Card*

don't miss half of the picture . . .

SEE AIRETOOL AT WORK!

Convincing proof of the rapid and efficient tube maintenance done by Airetool equipment can only be *fully shown* on the job!

We could talk forever . . . about the complete line of cutter, drill and brush cleaner heads to fit every size of straight and curved tubes . . . or the powerful, high-speed motors that provide extra-husky driving torque, and "load down" to low R.P.M. without stalling! We could tell you about Airetool's precise slip-fit ground construction that permits easy disassembly and reassembly without special tools . . . or any of the thousand and one reasons why we know that Airetool Tube Maintenance Equipment is foremost in its field!

Words alone convey but half the picture . . . we'd rather show than tell you—so ask your nearest Airetool representative for a demonstration . . . just name the time and the place!

Just one of the many efficient AIRETOOL combinations for rapid, economical, thorough tube maintenance . . . the series "6000" ball bearing motor, shown here with a single-expansion type cutter head, and the G-800 ball bearing thrust quick-rolling expander.

WRITE TODAY to The Airetool Manufacturing Co., 328 S. Center St., Springfield, Ohio—get full information about the complete line of Airetool Tube Maintenance Equipment for your specific industrial needs.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

REPRESENTATIVES in principal cities in U.S.A., Canada, Mexico, South America, England, Japan.

BRANCH OFFICES: New York, Philadelphia, Chicago, Tulsa, Houston, Baton Rouge.

Remember . . . there's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

3 grades of Aerocat® FLUID CRACKING CATALYST

for better fluidizing, circulating and attrition characteristics

in any fluid cracking unit

The importance of particle size distribution in catalyst efficiency is reflected in the names and performance of Cyanamid's three new grades of AEROCAT.

Following extensive research into existing fluid cracking unit needs, these grades were developed to cover the entire range of requirements. Now you can readily select the grade best suited to your unit operation and secure a higher degree of catalyst utilization through proper fluidization, circulation and reduced attrition. These grades represent a wide range, identified for your convenience by their Particle Distribution Index.

This is another advance in catalyst development that makes AEROCAT your most economical means to

- high octane yields
- high throughput
- low CO_2/CO ratio in flue gas
- high isobutane yield
- excellent heat, steam and sulfur stability

– all good reasons why 8 out of 10 users of synthetic catalyst specify AEROCAT Fluid Cracking Catalyst.

For details, write for a new technical data sheet "AEROCAT–Particle Size Distribution," or discuss your needs with our Technical Representative.

DESIGNED TO MEET ALL FLUID UNIT NEEDS

Aerocat 50/60 (Light) — for fluid units with low linear gas velocities, adequate dust disengaging space, excellent cyclone and Cottrell efficiency, low bed density needs.

Aerocat 60/70 (Intermediate) — for fluid units with moderate to high linear gas velocities, adequate catalyst recovery equipment.

Aerocat 75/85 (Narrow) — for fluid units with high linear gas velocities, moderate disengaging space, limited recovery equipment.

AMERICAN Cyanamid COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

(To obtain more data on advertised products see page 108)

Keep Heat Transfer Surfaces CLEAN...

SPECIFY

Vogt

SCRAPED SURFACE *Exchangers*

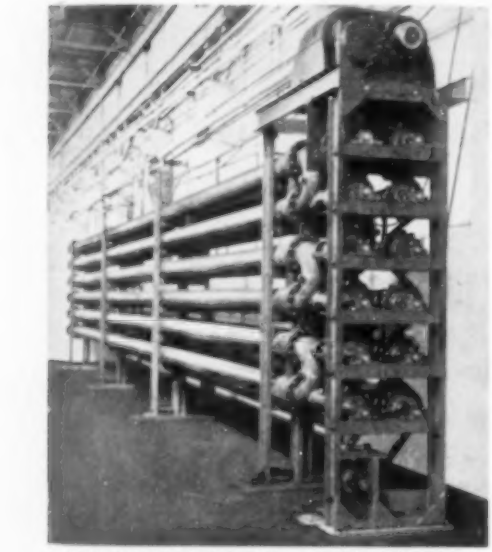
IF you are all "gummed up" with a tough heat transfer problem, Vogt Scraped Surface Exchangers will provide the answer. They have patented scraper elements which prevent fouling of the heat transfer surfaces and insure the highest rate of heat exchange between the product and the cooling or heating medium. The scrapers also continuously agitate the fluid and assist removal of solids from the unit.

DOUBLE PIPE EQUIPMENT is available in two types; EXCHANGERS, for cooling with water, brine, and cold filtrate, and for heating with steam or hot liquids; and CHILLERS, for use with volatile refrigerants such as ammonia, propane, and Freon. Both types have 8" jacket pipes and 6" inner pipes with scrapers.

SHELL AND PIPE TYPE UNITS are designed for use with volatile refrigerants and for heating fluids with steam or similar heating mediums. They consist of large welded shells each containing seven 6" scraped pipe sections.

Vogt Scraped Surface Exchangers serve profitably as oil chillers, crystallizers, and heaters in many processes in the petroleum and chemical industries. Their application to your heat transfer problems will receive the prompt attention of our Engineering staff.

Write for Bulletin PE-1



*DOUBLE PIPE UNIT. Drive end close-up of 12 section unit under test in our shop.

*SHELL and PIPE UNITS. Two of five units installed in a leading petroleum refinery.

*Patented

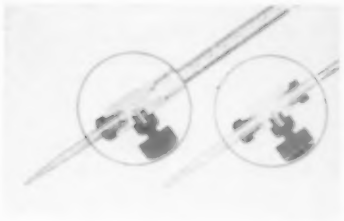
HENRY VOGT MACHINE CO

LOUISVILLE 10, KENTUCKY

Branch Offices:

NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO

ST. LOUIS • DALLAS • CHARLESTON, W. VA.



Needle-Valve Buret Control Eliminates Stopcock Problems

. . . and will perform titrations requiring micro measurements. Stopcock adjustments are eliminated as well as stopcock grease contamination. The valve is of glass and plastic, with liquid contacting only glass and teflon. Other plastic parts not contacted by the liquid are made of Hysol, which is resistant to acids, alkalis, salts and nearly all organic liquids. Buret tubes are calibrated to Bureau of Standard tolerances with a permanent fused-in ceramic scale. The Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.

Circle No. **34** *on Reply Card*

Free Trade Literature

Process Telemetering

. . . allowing up to twenty-nine multiple signals to be transmitted in both directions without regard to sequence; *Bulletin 9100* describes the "Autocon Telestep" giving advantages, available models, and applications. Automatic Control Co., 1005 University Ave., St. Paul, Minn.

Circle No. **35** *on Reply Card*

Hydraulic Surge Manual

. . . about analysis and control: 62-page manual discusses water hammer, surge suppressing devices, surge control with pneumatic suppressors, pulsation control and resonance, accumulators, and thermal expansion and compensation. Address requests on company letterhead to Cook Electric Co., MagniLastic Div., Chicago 14, Ill.

Do Not Use Reply Card

Air Coolers

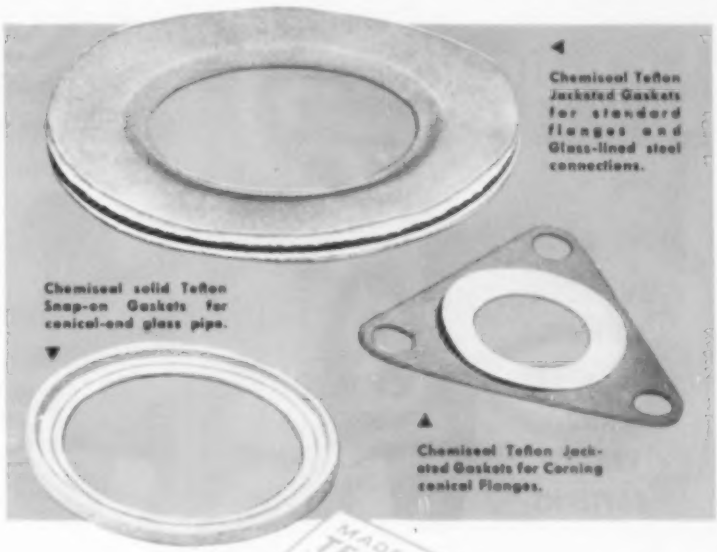
. . . for refineries, gas processing plants, chemical plants and compressor stations: *Cooling with Air* describes equipment, principles, operation and installations. Hudson Engineering Corp., Fairview Station, Houston, Tex.

Circle No. **36** *on Reply Card*

Impervious to

- ACIDS
- CAUSTICS
- SOLVENTS

• non-contaminating


Chemiseal Teflon Jacketed Gaskets for standard flanges and Glass-lined steel connections.
Chemiseal solid Teflon Snap-on Gaskets for conical-end glass pipe.
Chemiseal Teflon Jacketed Gaskets for Corning conical Flanges.
MADE OF TEFLON

Chemiseal Gaskets

Here are Gaskets that will seal against any chemical your process equipment and piping can handle—and then some. With proper installation, they will last as long as the equipment, corrosion-wise.

And they are made specifically to suit every connection problem—every pipe and nozzle material requirement, whether glass, ceramics, stainless, Karbate, Haveg, glass-lined steel, etc.

They are designed to protect these costly piping materials—usually low in impact strength—by providing the necessary cushioning effect to permit a positive seal at low bolt loads. Solve your gasketing problems once and for all. Write for Catalog No. TG-953.

UNITED STATES GASKET COMPANY

CAMDEN 1 • NEW JERSEY

FABRICATORS OF duPont TEFLON
Kellogg KEL-F AND OTHER PLASTICS

Representatives in Principal Cities Throughout the World

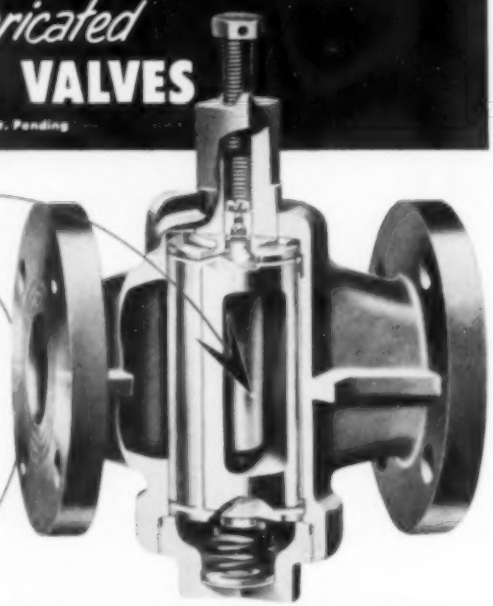
(To obtain more data on advertised products see page 108)

No. 3* of . . .

12 REASONS WHY
YOU SHOULD BUY AND USE
LOW-PRICED

HOMESTEAD
Lubricated
PLUG VALVES

Pat. Pending



* AVAILABLE IN 100% PIPE AREA AND VENTURI PATTERNS

Insist on 100% pipe area **HOMESTEAD LUBRICATED PLUG VALVES** to avoid costly pressure losses. If a slight restriction is unimportant, worthwhile savings can be made by using our Venturi type valve.

Your choice of ports is only **ONE REASON WHY** you should buy and use, *low priced* **HOMESTEAD LUBRICATED PLUG VALVES.**

HERE ARE ALL TWELVE

1. Reinforced Teflon packing ring.
2. Completely controlled high-pressure lubricant system.
3. 100% pipe area and venturi patterns.
4. No spring torsional stress.
5. No mechanical adjustments.
6. Two lubricants handle most services.
7. Extremely close tolerance between sealing surfaces.
8. Triple head-seal with Lubricant and Teflon packing ring.
9. Plug floated on Teflon surfaces.
10. Leak-proof, double-ball-and-lubricant-sealed check valve.
11. Full-threaded screw assures clean lubricant.
12. Extruded lubricant shows a full protecting system.

FOR CATALOG AND COMPLETE DETAILS MAIL COUPON TODAY

Without obligation, send Reference Book 39—Section 5 on HOMESTEAD LUBRICATED PLUG VALVES.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

HOMESTEAD VALVE MANUFACTURING COMPANY

Serving Since 1892

P. O. BOX 43 CORAOPOLIS, PA.

What's New!

Telemetering Applications

. . . for power flow, generation, oil pressure, oil flow and other values: *Bulletin ATIC-929* discusses uses, instrument requirements, interrogative measurement and supervisory control as a switching media. Motorola Communications & Electronics, Inc., Technical Information Center, 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle No. **37** *on Reply Card*

Air Pollution Report

. . . presents basic conceptions which underlie research work: *Current Conceptions on Air Pollution* discusses classifications, measurements, weather effects, historical records, and hydrogen sulfide incidence. Industrial Hygiene Foundation of America, Inc., 4400 Fifth Ave., Pittsburgh 13, Pa.

Circle No. **38** *on Reply Card*

Oil-Water Separation

. . . for refinery waste water: *Technical Reprint T-124* discusses methods of treating waters containing oil, and the de-oiling of refinery waste water for reuse. Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y.

Circle No. **39** *on Reply Card*

Petroleum Processing Index

. . . for 1954: including subject and author indexes for all feature articles and regular departments for the 12 issues of this magazine published during the past year. Available now from McGraw-Hill Petroleum Publications, 330 West 42nd St., New York 36, N. Y., or . . .

Circle No. **40** *on Reply Card*

Thermocouple Elements

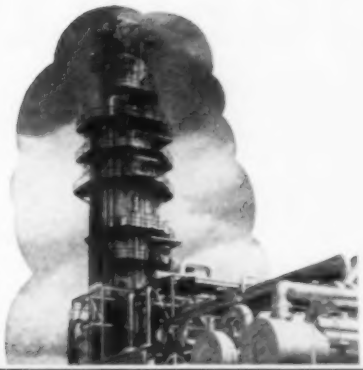
. . . and bare thermocouple wire: *Form No. 14-15-54* gives general application data, sizes, and prices for iron-constantan, copper-constantan, chromel-alumel, platinum, and platinum-rhodium thermocouple elements and wire. Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

Circle No. **41** *on Reply Card*

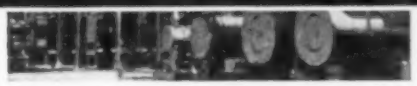
Venturi Valves

. . . allowing non-turbulent flow and tight shut-off: *Valves by P-K* describes installations and operating principles of these and control and barstock valves. P-K Industries, Inc., 27 Porete Ave., North Arlington, N. J.

Circle No. **42** *on Reply Card*



At Fawley, England



Monel gives Esso a high level of performance in fractionating tower tops

Fitting Monel internals in Monel-Clad top of fractionating tower. Top sections of fractionating towers are protected from corrosion by Monel cladding. In this area, distributor pipes, trays, bubble caps and fittings are solid Monel.

About two years ago, the two distillation units in Esso's Fawley refinery went on stream. Designed by Standard Oil Development Company and constructed by Foster Wheeler, Ltd., it is the largest refinery ever built at one time anywhere.

One unit is a single-stage atmospheric tower. The other is a two-stage atmospheric and vacuum unit. Both use Monel® in the top sections . . . Monel trays, Monel bubble caps, Monel pipe, Monel-Clad linings.

When examined after the first year, the Monel in the single-stage unit was still in "as new" condition. Today, both atmospheric towers are breaking down corrosive crudes originating in Arabia, Iraq, and other sections of the Middle East.

Reasons for choosing Monel

For one thing, Monel costs less per pound than other alloys able to withstand the corrosion. Furthermore, it requires no heat treatment since its corrosion resistance is not impaired by welding. Then, too, Monel is easy to form . . . lends itself well to lining.

But the most important reason for choosing Monel is the way it stands up to the various corrosives found in upper sections of fractionators.

In this area, reflux pushes vapor temperatures down to about 250° F. Walls and trays cool vapors further. As they go below the dew point, aqueous hydrochloric and sulfuric acids form in the condensate. Corrosive salt compounds may be present also.

The record of Monel in resisting all these forms of corrosion when temperatures are under 500° F., is outstanding . . . not only in atmospheric towers, but in overhead condensers, too.

If your next inspection of either type of equipment shows corrosion, why not investigate the use of Monel? A letter addressed to Inco's Corrosion Engineering Section will bring full information regarding the application of Monel in this corrosive service. No cost or obligation, of course.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N.Y.

INCO Nickel Alloys

Monel...for minimum maintenance

WEDGEPLUG

NON-LUBRICATED
STEEL PLUG VALVES

Quality

STOCKHAM

VALVES AND FITTINGS

Write for
STOCKHAM and
WEDGEPLUG
Catalogs

WEDGEPLUG VALVE COMPANY, INC.
NEW ORLEANS 25, LA.

An Affiliate of

STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

Selective Hydrogenation

. . . with platinum catalysts: *Form No. 4347-A-EX2M* describes group and step selectivity as related to reactants and reaction conditions and gives abstracts for 10 U. S. patents concerning hydrogenation with platinum. Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

Circle No. **43** *on Reply Card*

New Receiver Recorder

. . . for pneumatic and electric transmission systems: *Specification E12-5* describes features of recorder, receiver, and integrator, and gives typical measuring circuits, specifications, applications and recorder selection. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle No. **44** *on Reply Card*

Positive Displacement Metering

. . . of process liquids with packless proportioning pump: *Bulletin AP-54* describes the "Hills-McCannameter" for metering flows from 5 c.c. to 6 gph with pressures up to 10,000 psi. Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.

Circle No. **45** *on Reply Card*

Stainless Steel Properties

. . . for types "No. 20" and "No. 20-Cb": *Form 108A* gives specifications and information on corrosion resistance, physical and mechanical properties, forms and shapes available, applications and working characteristics. The Carpenter Steel Co., Alloy Tube Div., Union, N. J.

Circle No. **46** *on Reply Card*

Super Steel Alloys

. . . with high strength and corrosion resistance for use in high temperature oil refinery equipment: *Super Alloy* pamphlet describes uses, physical properties, compositions, and installation. Universal-Cyclops Steel Corp., Dept. 21, Bridgeville, Pa.

Circle No. **47** *on Reply Card*

Electrostatic Precipitator Cleaner

. . . device which operates automatically and continuously: bulletin on "MI Rapper" gives operating principles, component illustrations, and a summary of its features. Research-Cottrell, Inc., 405 Lexington Ave., New York 17, N. Y.

Circle No. **48** *on Reply Card*

Self-Priming Centrifugals

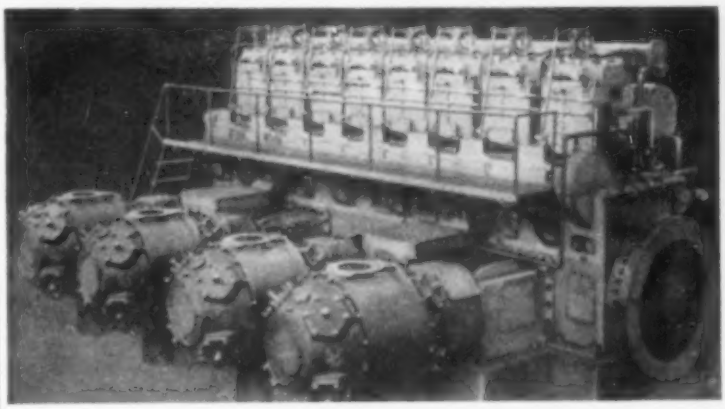
. . . for non-corrosive service can pump liquids containing solids 10% by volume and ¾ the size of suction opening: *Bulletin W-395-B2* gives description, performance characteristics and dimensions for 1½ to 4 in. sizes with capacities to 550 gpm. Advertising and Sales Promotion Dept., Worthington Corp., Harrison, N. J.

Circle No. **49** *on Reply Card*

Hazardous Gas Detection

. . . measures concentrations as low as 5 parts per billion for combustible materials, carbon monoxide, hydrogen, hydrogen sulfide, oxygen, and various hydrocarbon and organic compounds: *Bulletins 201, 301, and 501* give specifications, uses and principles of operation. Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y.

Circle No. **50** *on Reply Card*



How one refinery eliminated scale build-up in compressors

Oakite Airefiner No. 52 prevents scale formation—cuts downtime, maintenance

Every 6 to 8 weeks a Southwestern refinery had to run acid through compressor water jackets to remove thick lime scale deposits. That meant compressors down for half a day. What could Oakite do?

The Oakite Man first descaled the jackets with Oakite Compound No. 32. Then he charged the spray pond with Oakite Airefiner No. 52, and set up a schedule for maintaining proper pH in the solution.

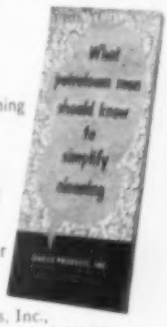
Results: Manifold temperatures reduced—no more descaling, no more cracked blocks or heads, no more compressor downtime.

Proving that—in industrial cleaning it always pays to consult Oakite.

Call your Oakite Technical Service Representative. His experience is yours to draw on. He'll study your cleaning problem, suggest and demonstrate the best material and method. He'll keep checking back to see that you get top quality cleaning at low cost. Call him today!

FREE HANDBOOK—full of facts on

- Drum reconditioning
- Descaling
- Cleaning tanks
- Salvage cleaning
- Paint stripping
- Cleaning tank car interiors



Write Oakite Products, Inc., 50D Rector St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE petroleum service division

Technical Service · MATERIALS · METHODS · SERVICE · Representatives in Principal Cities of U. S. and Canada

(To obtain more data on advertised products see page 108)

Infrared Gas Analysis

. . . methods applied to light hydrocarbons: *The Application of Infrared Methods to Light Hydrocarbon Gas Analyses* gives a detailed example of procedure and calculations for a typical 5-component analysis, outlines advantages of infrared and mass spectrometer methods, describes instrumentation, services and laboratory space needed. The Perkin-Elmer Corp., Norwalk, Conn.

Circle No. **51** *on Reply Card*

Floating Roof Tank Vapor Seal

. . . with no moving parts, climate-proof and non-corrodible: *Bulletin TS* describes the "Tubeseal" system, giving specifications and illustrations. Hammond Iron Works, 630 Fifth Ave., New York 20, N. Y.

Circle No. **52** *on Reply Card*

Laboratory Equipment Catalog

. . . including balances, colorimeter-spectrophotometers, demineralizers, centrifuges, blenders, glassware, and ovens: *What's New for the Laboratory* gives descriptions and prices. Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Circle No. **53** *on Reply Card*

Magnetic Energy Spectrum

. . . chart and laboratory equipment listing: The *Palo Retort* shows the wavelengths of the visible and ultraviolet spectrum, and gives descriptions and prices for laboratory equipment. Palo Laboratory Supplies, 81 Reade St., New York 7, N. Y.

Circle No. **54** *on Reply Card*

Organic Chemicals Properties

. . . on more than 350 synthetic organic chemicals: booklet *F-6136* gives gravities, vapor pressures, solubilities in water, and boiling, freezing, and open cup flash points. Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.

Circle No. **55** *on Reply Card*

Methyl Cellosolve Acetate

. . . as a solvent for cellulose acetate and other cellulose esters: *F-8623* gives physical properties, specifications, solubility with resins and physiological properties. Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.

Circle No. **56** *on Reply Card*

Maleic Anhydride

. . . as a resin-former and raw material for organic reactions: booklet contains chemical and physical data, uses in phthalic-type alkyd resins, upgrading of drying oils, and Diels-Alder and other synthesis reactions. Monsanto Chemical Co., St. Louis 4, Mo.

Circle No. **57** *on Reply Card*

Refractory Concrete Manual

. . . for calcium-aluminate cement, "Lumnite", used as binder for refractory and insulating aggregates; *Refractory Concrete Manual* describes mix proportions and aggregate, making refractory cement from preparation through cure, insulating values, structural design, reinforcing, and industrial applications. Universal Atlas Cement Co., Lumnite Div., 100 Park Ave., New York 17, N.Y.

Circle No. **58** *on Reply Card*

"Alamask"

offers a complete and diversified line of reodorants for petroleum and allied products

No longer need the products of the petroleum industry inflict upon their users the obnoxious odors resulting from the mercaptans and sulfides in their processing.

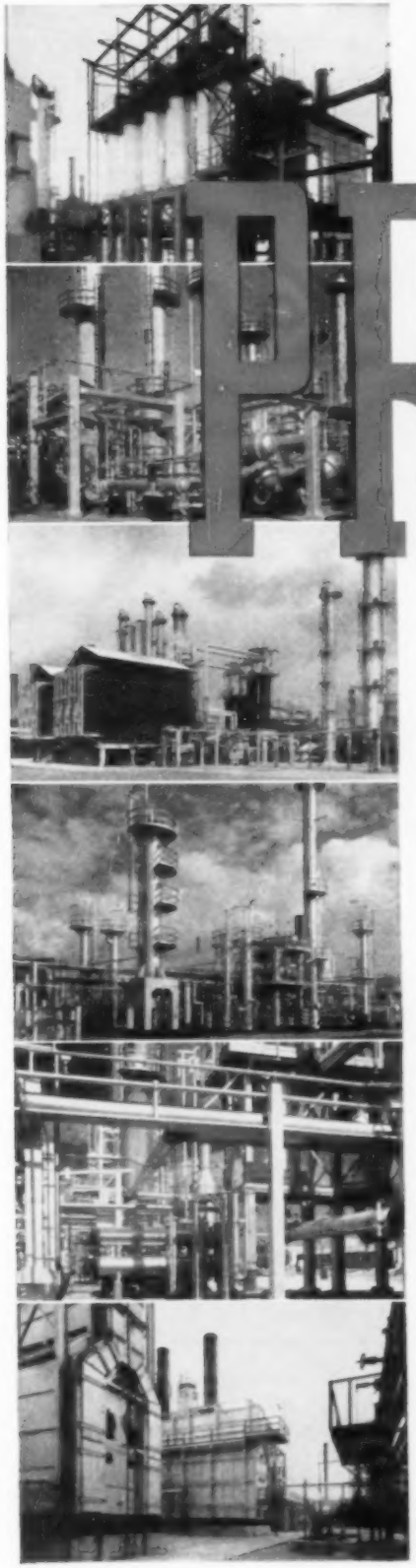
Years of development work and product-testing have culminated in a complete line of Alamask® reodorants that can successfully mask the objectionable odors of many petroleum products. Check this table to see which Alamask reodorants will solve your malodor problems:

"ALAMASK"	GASOLINE FRACTIONS	ASPHALTIC COMPOUNDS	KEROSENE BLENDS	COAL SPRAY OILS	SPACE HEATERS	CUTTING OILS	CLUTCH OILS	DIESEL FUELS	JET FLUIDS	MINERAL SPIRITS	WAXES	NAPHTHA	BURNER OILS
AAM								X					
AO						X	X						
AR		X								X			
BGM		X											
BN						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.19	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

Rhodia's chemists and engineers, experienced in odor abatement and waste disposal, will provide technical assistance to you in your efforts to correct malodors.

For complete information on these new, highly-effective reodorants, write today to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 230 Park Avenue, New York 17, N. Y.

Rhodia INC.



CONSTRUCTION BY

PROCON

A company is as young as the unbounded energies and ambitions of the men who comprise its personnel . . . as old as their years of experience . . . and as competent as the sum of their proved capabilities.

Within the Procon organization, these factors add up to a substantial and impressive figure . . . a combination of assets that has enabled us to handle successfully a great many construction jobs of considerable magnitude and complexity . . . to do them efficiently and economically . . . with completions on schedule.

Procon is a well-rounded organization, fully equipped to handle all construction jobs in any part of the world. Procon service is complete . . . designing, engineering, procurement, construction. Procon clients are leaders of industry whose satisfaction is best expressed by the continuance of their patronage.

When your plans for the future include a construction project, talk it over with a Procon engineer. We believe you'll find it time well spent.

PROCON *Incorporated*

PROCESS CONSTRUCTION

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

AFFILIATED COMPANIES

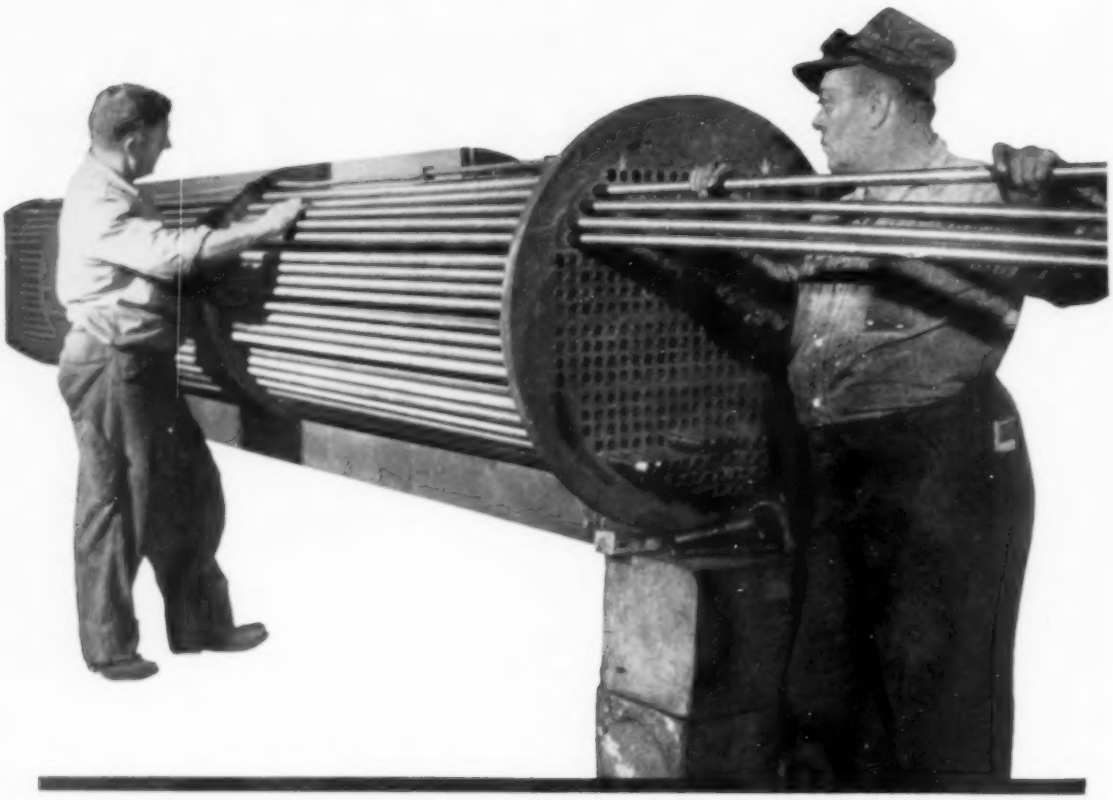
PROCON (CANADA) LIMITED
40 ADVANCE ROAD
TORONTO 18, ONTARIO

PROCON (GREAT BRITAIN) LIMITED
112 STRAND, LONDON, W. C. 2

(To obtain more data on advertised products see page 108)

TO MAINTAIN HIGH PRODUCTION

AND REDUCE DOWN-TIME...



ESSO installs 7,956 Anaconda Cupro Nickel, 30%-702 Tubes in condensers and coolers at Bayway Refinery

This condenser is used in the No. 1 Fluid Catalytic Cracking Unit at the Bayway Refinery of Esso Standard Oil Company at Linden, N. J. The unit produces about 25,000 barrels of petroleum products daily—ranging from high octane gasoline to heating oils.

7,956 ¾" Cupro Nickel, 30%-702 Tubes were supplied by Anaconda for the condensers and coolers of this cracking unit. On the shell side, these tubes are subjected to temperatures as high as 350°F at 75 PSI by process streams containing both sulfur and salt compounds. On the tube side, the summer salt water temperature ranges from 80°F at the inlet to 110°F at the outlet.

Information gathered from test runs within the refinery indicates these ANACONDA Cupro Nickel, 30%-702 Tubes have a life expectancy in this service of from 6 to 12 times greater than tubes made of Admiralty Alloy.

ANACONDA Cupro Nickel, 30%-702 Tubes are recommended where process liquids, vapors and cooling waters are corrosive—particularly where temperatures are too high for other copper alloys. Tubes of this alloy also have superior resistance to sea water at high velocities. They have good physical properties at elevated temperatures and resist stress-corrosion cracking.

Our files bulge with a collection of tube performance case histories that can answer many of the corrosion problems you face. We can put the information in these files to work for you at once—to help you select the one best alloy for your job. Write, outlining your operating conditions, to Dept. TD, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass, Ltd., New Toronto, Ont.

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers

What's New!

Electric Proportioning Control

. . . in compact form for processes: *Folder ND47(7)* describes equipment and circuitry for controllers, recorders, and indicators with proportional control action, position-adjusting action, and duration-adjusting action. Leeds & Northrup, 60 E. 42nd St., New York 17, N. Y.

Circle No. **59** *on Reply Card*

Color Stabilizer

. . . for fuel oils: *Technical Bulletin O-97* gives uses, physical properties, storage, handling, and toxicity information for "Santolene J." Monsanto Chemical Co., St. Louis 4, Mo.

Circle No. **60** *on Reply Card*

New Pressure Vessel Steel

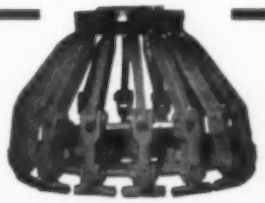
. . . remains ductile at sub-zero temperatures and has three times the yield strength of carbon steel; *Publication No. ADVL-317-54* describes "Carilloy T-1," its properties and uses, and destructive testing by pressure and dropping. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

Circle No. **61** *on Reply Card*

Induced-Draft Cooling Towers

. . . for the petroleum, chemical, petrochemical and other industries; *CT-ID-0.002, Cooling Water for Industry*, illustrates the principles and methods of construction for towers, water distribution, and process applications. The Fluor Corp. Ltd., 2500 S. Atlantic Blvd., Los Angeles 22, Calif.

Circle No. **62** *on Reply Card*



BARRETT automatic

Filling and Crimping Equipment

for handling greases and other viscous fluids.

- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT Manufacturing Co.

P. O. Box 8096, Houston 4, Texas

4330

MEASURE, CONTROL LIQUID DENSITY

continuously and automatically with the

Princo Densitrol PRINCO

Process industries will welcome the new DENSITROL—the precision instrument that gives a continuous reading of density in flowing liquids such as sugar syrups, brine, acids. DENSITROL electrical indicators or recorders can be located remote from the sampling chamber itself. If desired, DENSITROL can be linked with control mechanisms for automatic regulation. For information on temperature and pressure ranges, calibrations, and other specifics, request Bulletin W-3.

PRECISION THERMOMETER & INSTRUMENT CO.
1434 Brandywine Street, Philadelphia 30, Pa.

Clean Your Floors with COMPLETE SAFETY in Explosive Atmospheres!

EXPLOSION-PROOF AUTO SCRUBBER

EXPLOSION-PROOF SINGLE-DISC POLISHER

Leaders in refining, processing and manufacturing industries have selected Lincoln Explosion-Proof Floor Maintenance Machines. This proves Lincoln machines operate with absolute safety and effect substantial floor maintenance savings. A free demonstration will prove you can save up to 75% on your floor maintenance costs. Mail coupon today.

All electrical parts sealed for explosion-proof operation and carry Underwriter's Laboratories approval.

REPRESENTATIVE USERS *include*

- E. I. DuPont de Nemours Co.
- Douglas Aircraft Co.
- General Mills, Inc.
- Shell Pipe Line Co.
- The Upjohn Co.

LINCOLN-SCHLUETER FLOOR MACH. CO. 1251 West Van Buren Street, Chicago 7, Illinois
Without obligation, please send complete information on:
( ) Lincoln EXPLOSION-PROOF AUTO-SCRUBBER
( ) Lincoln EXPLOSION-PROOF Single-Disc SCRUBBER and POLISHER
( ) And arrange for a FREE DEMONSTRATION
Name
Firm
Address
City Zone State

Lincoln-Schlueter FLOOR MACHINERY COMPANY
1251 WEST VAN BUREN ST., CHICAGO 7, ILLINOIS

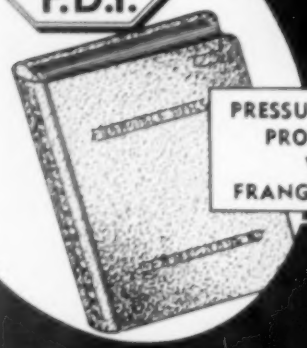
MORE THAN 50 YEARS OF SERVICE

WORLD'S MANUFACTURER OF THE MOST COMPLETE LINE OF FLOOR MAINTENANCE EQUIPMENT

F.D.I.

COMPLETE DATA SHEET FILE ON

PRESSURE SYSTEM PROTECTION WITH FRANGIBLE DISCS



With more than 25 years' experience in applying known scientific principles to pressure protection together with carefully supervised experimental work, our engineers have acquired a wealth of highly specialized knowledge in the field of metal behavior.

We offer this information to you as a continuing data sheet file. It's free! Write for it today!

FRANGIBLE DISCS, INC.
PENNS GROVE, N. J.

arrest YOUR CATALYST FINES...

(their escape means continuous added costs and annoyance to your neighbors)

MMC CATALYST FILTERS

replace cyclones and electrostatic precipitators and offer

- complete catalyst retention
- low pressure drop
- hi-temp service
- low maintenance cost

Write for literature requesting Bulletin

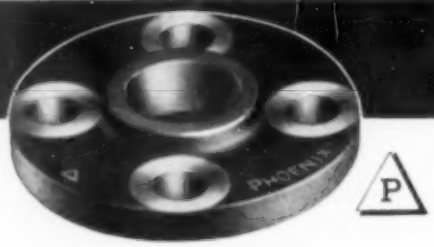
Another engineered filtration service using porous stainless steel by

MICRO METALLIC CORPORATION
13-L SEA CLIFF AVE. GLEN COVE, N. Y.

PALL
The Pall Filtration Companies
Micro Metallic Corporation · Porous Plastic Filter Company · Aircraft Porous Media, Inc.

PHOENIX *Drop-Forged* FLANGES MEAN...

MAXIMUM STRENGTH



Long life is assured with Phoenix maximum strength flanges. Forged of mild steel, they are available in a wide range of styles and sizes. Meet ASA requirements and ASME and ASTM specifications.

NEW CATALOG!
Send for free brochure showing Phoenix Complete Line.

FLANGE DIVISION
PHOENIX MANUFACTURING CO.
Catasauqua, Pa. • Joliet, Ill.

YOU CAN STILL GET THESE POPULAR REPRINTS

"REFINERY INSTRUMENTS— WHAT MAKES THEM TICK?"

A series of 8 articles by Cornelius E. Shannahan, instrument engineer with M. W. Kellogg Co., dealing with the four basic refinery instruments (pressure, temperature, flow, level), plus sections on controllers, control valves and pneumatic transmission—40 pages, 8¼ x 11¼, paper bound (1951-2) $1.00

"VAPORIZATION EQUILIBRIUM CONSTANTS AND ACTIVITY COEFFICIENT CHARTS"

41 working-scale charts (21 equilibrium constant charts for the hydrocarbons from methane to 700°F. boiling point, and 20 activity coefficient charts), plus a description of how to use them—48 pages, 8½ x 11, paper bound (1949) $1.50

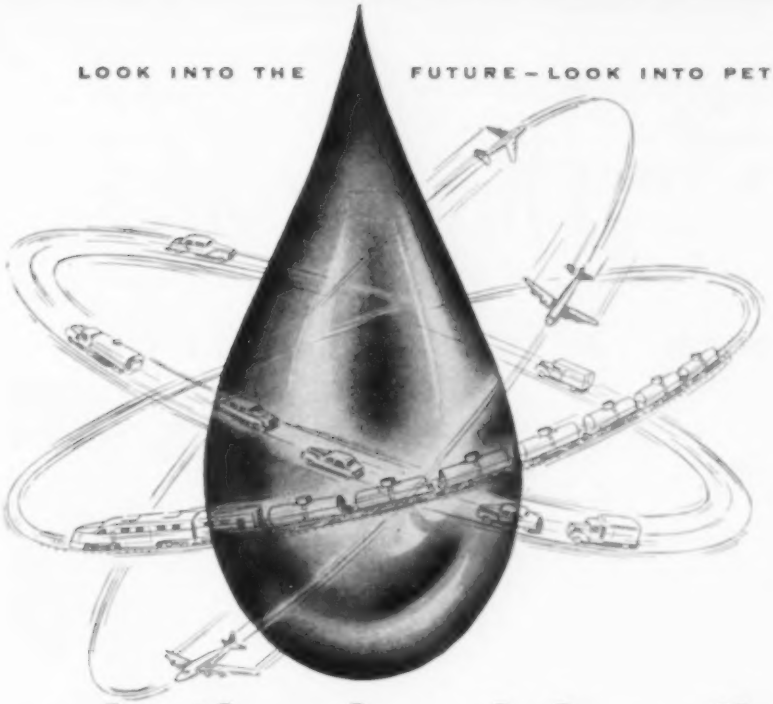
ADDRESS READER'S SERVICE DEPARTMENT

PETROLEUM PROCESSING NOW

330 West 42nd Street, New York 36, N. Y.

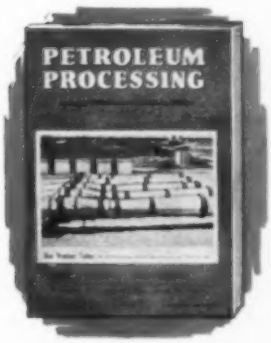
Note: New York City residents add 3% Sales Tax

LOOK INTO THE FUTURE—LOOK INTO PETROLEUM PROCESSING



what's ahead for oil—and you?

Petrochemicals, the fast growing offspring of the world's fastest changing industry, will make a tremendous new market for all process equipment in the next ten years. Write for free plant directory and market information.



PETROLEUM processing is an industry constantly building a new plant to make new products for fast changing markets. Obsolescence is more rapid than in any other major industry. Today it is geared to mass production of high octane gasoline for 10:1 ratio automobile engines. Tomorrow it will be making rocket fuel, new jet fuels, and synthetic fuels if necessary. The industry moves fast, thinks big and spends big.

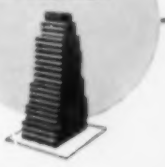
If you make process equipment, components for process equipment or materials which can be used in petroleum processing, you should concentrate your sales and advertising effort on this industry for the next ten years. It will be the biggest market for processing equipment. To sell your product to refineries you need specialized sales attention—salesmen and engineers who really know the complex industry and its many problems. To do a real advertising job you need a specialized publication geared to that industry.

Petroleum Processing is preferred by more of the real buying factors in these important buying elements of the industry: Plant engineering and maintenance staffs . . . Plant process design engineers . . . Home office engineers . . . Research and development personnel . . . Engineering and construction firms.

Petroleum Processing has the balance editorially to serve all these elements. It is the only publication that has the quantity of circulation needed to cover all branches (36% more than the effective circulation of the second publication). It has the backing of a great business paper publisher to keep it ahead of the world's fastest changing industry. To sell more process equipment in the ten big years ahead—advertise for those sales, NOW, in *Petroleum Processing*.

PETROLEUM PROCESSING

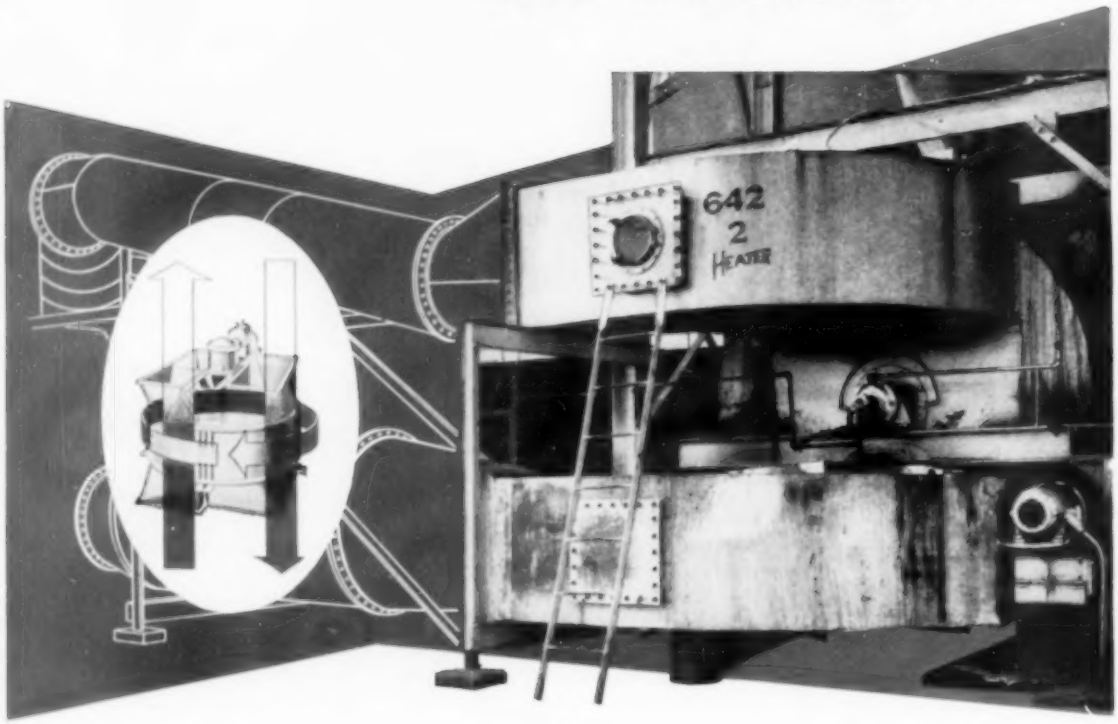
NOW
A McGRAW-HILL PUBLICATION



330 WEST 42ND STREET, NEW YORK 36, N. Y.

Replace Still Convection Surfaces . . .

. . . with a Ljungstrom Air Preheater



Wherever You Burn Fuel, You Need LJUNGSTROM

In purchasing new equipment — or modernizing existing equipment — one way to save impressive amounts of capital as well as operating expense is to design for a Ljungstrom Air Preheater.

Because the Ljungstrom promotes such greatly increased heat liberation in the furnace, the convection bank of oil tubes can generally be eliminated from the design. This can in itself *more than pay the cost of the Ljungstrom installation.*

Add to this the proved fuel savings . . . the higher product quality . . . greater throughout possible with a Ljungstrom — and you will see why the Ljungstrom is an eminently practical piece of equipment to be considered wherever fuel is burned.

In these days of high fuel costs and skyrocketing demands for petroleum products, every refinery should consider a Ljungstrom whenever equipment is being purchased or modernized. Call or write The Air Preheater Corporation for complete details.

THE AIR PREHEATER CORPORATION
60 East 42nd Street, New York 17, N. Y.

What's New!

Plastic Pipe, Fittings & Valves

. . . for petroleum products for temperatures from —40° F. to +170° F. and made of thermoplatsic multi-polymer: *Bulletin 80-A* gives general properties, chemical resistances, sizes, pressures, and installation, fabrication and price data. American Hard Rubber Co., 93 Worth St., New York 13, N. Y.

Circle No. **63** *on Reply Card*

Compressed Air Water Traps

. . . for automatic drainage of water from compressed air inter-coolers, after-coolers, receivers, separators and drip points; *Bulletin No. 2022* gives uses, specifications, dimensions, capacities, and prices. Armstrong Machine Works, Three Rivers, Michigan.

Circle No. **64** *on Reply Card*

General Purpose Additives

. . . for fuel oil and gasoline or lubricating oil; corrosion inhibitors, asphalt anti-stripping agent and others; *Bulletin No. SP-33* gives physical and chemical properties, suggested applications and chemical reactions for tertiary - butylamine, tertiary - octylamine, "Primene 81-R" and "JM-T" and "Primac JMA-T." Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

Circle No. **65** *on Reply Card*

Graphite Centrifugal Pumps

. . . ranging in size from 25 to 2000 gpm. at 20 to 100 ft. head in 6 models; *Bulletin 854* gives construction features, corrosion resistance, dimensions, and performance charts for "Impervite" graphite centrifugal pumps. Falls Industries, Inc., Aurora Road, Solon, Ohio.

Circle No. **66** *on Reply Card*

Ball-Bearing Swivel Joints

. . . for use on expanding, contracting or pulsating fluid or gas lines; *Catalog G-4* describes complete line and gives operating data and typical industrial applications. Chiksan Co., Brea, Calif.

Circle No. **67** *on Reply Card*

Boiler Water Level Controls

. . . and safety devices with operating specifications; pocket size *Bulletin SC-5* includes contractors' discount and net price sheet. McDonnell & Miller, Inc., 3500 North Spaulding Ave., Chicago 18, Ill.

Circle No. **68** *on Reply Card*

VESSELS ASME CODED
Complete design, engineering and fabricating facilities for buildings, pressure vessels, stacks, barges, staging.
THE ST. MARY STAMP IS THE STAMP OF SUPERIORITY
COMPLETION AS PROMISED!
DESIGN
ENGINEERING
FABRICATION
BY
ST. MARY IRON WORKS
ST. MARY IRON WORKS
FRANKLIN, LOUISIANA - U. S. A.
Steel Fabricators for Half A Century

GET YOUR FREE COPY . . .

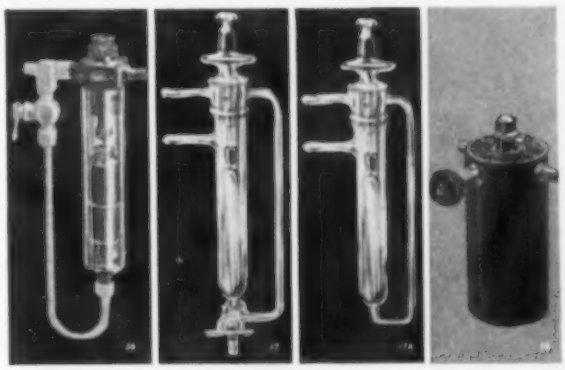
. . . of the 1954 Editorial Index for PETROLEUM PROCESSING. It is now ready, and we'll be glad to send you yours.

Circle No. 40 on the Reader's Service card in this issue (you'll find it between pages 108 and 109), fill in your name and address, and drop the card in the mail. We'll do the rest.

—The Editors

CARTESIAN

for automatic vacuum and pressure control



MANOSTATS

They remember your vacuum setting even after shutting down system! Exclusive with Emil Greiner! No other instruments in the field can compare with these remarkable Cartesian Manostats for sensitivity, accuracy and reliability. Designed on the simple phenomenon of the Cartesian Diver, their construction, installation and operation is uncomplicated and dependable.

For complete information, write for Constant Pressure and Vacuum Control Bulletin.

The EMIL GREINER Co.

20-26 N. MOORE STREET (DEPT. 231, N. Y. 13, N. Y.)

The Emil Greiner Co., Dept. 231
20-26 N. Moore Street, New York 13, N. Y.
Please send me Cartesian Manostat Bulletin.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

What every reader of . . .

PETROLEUM PROCESSING *should know!*

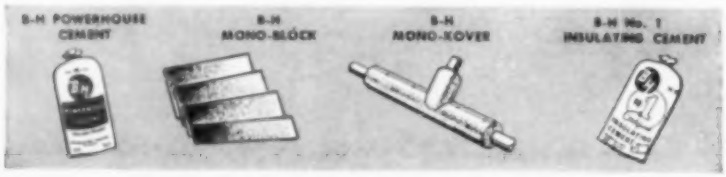
- Extra Light Density
- Easily Cut and Fitted
- Six Foot Lengths
- Resilient, Flexible
- Won't Break or Crumble
- Easy to Paint
- Highly Efficient
- No Coarse Fibers
- Takes Rough Handling
- Easily Nested
- Non-Corrosive
- Won't Rot, Decay, Mold
- Lower Applied Cost
- Factory Applied Vapor Barrier

Baldwin-Hill COMPANY

1601 BREUNIG AVE., TRENTON, N. J.

Kalamazoo, Mich. • Huntington, Ind. • Temple, Tex.

Send for bulletin with data on how to apply, properties, selection help, sizes and thicknesses available



What's New!

Volatile Liquid Pumps

. . . for moving material such as butane, propane and anhydrous ammonia from tank car to storage tank; *Bulletin H-609-B1A* gives specifications and performance curves for "LPG" and "LPGA" units for transferring volatile liquids and residual vapors. Worthington Corp., Holyoke, Mass.

Circle No. **69** *on Reply Card*

Recording Spectrophotometer

. . . Covering the ultraviolet to near-infrared range; *Bulletin 352* describes the model "DK" utilizing the double-beam optical principle with a single quartz monochromator over a range of 220 to 2700 μ. Beckman Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle No. **70** *on Reply Card*

Industrial Chemicals

. . . including boron, sodium, potassium, lithium, bromine, and agricultural chemicals; *Product Catalog* gives descriptions, properties, applications, and a listing of available refrigerants. American Potash & Chemical Corp., 3030 W. 6th St., Los Angeles 54, Calif.

Circle No. **71** *on Reply Card*

Emulsified Asphalt Coatings

. . . for water repellant properties, both indoors and exposed to weather; *AIA File No. 7-A-1* and *Specification LC-2* give uses, description, properties, testing and methods of applying for "Laykold Weathercoat." American Bitumuls & Asphalt Co., 1200 State St., Perth Amboy, N. J.

Circle No. **72** *on Reply Card*

Graphite Combustion Chambers

. . . for the production of hydrogen chloride: *Catalog Section S-7530* describes the chambers and burner nozzles with recommended accessories, installation and operation procedures. National Carbon Co., 30 E. 42nd St., New York 17, N. Y.

Circle No. **73** *on Reply Card*

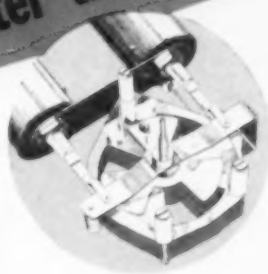
Inert Catalyst Carriers

. . . made of diatomite material: folder *FA-49A* describes "Celite" types, and advantages concerning uniformity, microporosity, density, thermal stability etc. Johns-Manville, 22 E. 40th St., New York 16, N. Y.

Circle No. **74** *on Reply Card*

An unbeatable pyrometer for any range between -300° and +2800°F.

DYNALOG* ... the electronic potentiometer that has no slidewire!



This simple variable capacitor is important to potentiometer users because it eliminates the conventional, troublesome slidewire altogether; and it gives Dynalog Instruments the continuous *stepless* balancing which assures higher accuracy, closer control.

*Reg. U.S. Pat. Off.

. . . no batteries to standardize!

TOPS in simplicity . . . unequalled in its combination of accuracy, sensitivity, and speed of response . . . the Dynalog Potentiometer with standard thermocouples gives you unerring temperature measurement for any range up to 2800°F. Featuring *sustained* accuracy of ¼ of 1% of scale, it's an instrument of laboratory precision built to withstand the severest industrial conditions.

Unprecedented freedom from maintenance is the direct result of unique Dynalog design. There's no slidewire, no battery to standardize. There are no gears, belts, or high speed reversing motors. There's nothing to wear and cause dead space.

Single pen recording models provide full scale pen travel in 3 seconds standard, or as fast as 1 second without extra cost. The Multi-Record Dynalog provides color-coded records of up to 6 points at 6 second intervals. Both types give the convenience and low cost of circular charts.

Dynalog Potentiometers are also used for the measurement of pH, oxidation-reduction potential, and for other applications in which the process variable can be converted to a dc millivolt signal. They are available for pneumatic or electric control.

Write for your copy of Bulletin 427-1 which gives the whole story.

THE FOXBORO COMPANY, 911 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO POTENTIOMETERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

INTERESTED IN

UNIFINING*

FOR DESULFURIZATION AND UPGRADING

* First Commercial Unifining Unit
United Refining Co.
Warren, Pennsylvania

UNIFINING should be of particular interest to all operators of catalytic reformers which produce by-product hydrogen.

• Harshaw is the exclusive producer of the Union Oil Company of California cobalt-molybdate catalyst used in the recently announced "Unifining" desulfurization and upgrading process. This rugged, commercially proven catalyst is supplied in the form of cylindrical tablets conforming to rigid physical and chemical specifications established by Harshaw and Union Oil Company of California. Stability at high temperatures permits repeated regenerations if and when necessary.

Please contact Harshaw for further information on this catalyst.

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 East 97th Street, Cleveland 6, Ohio

Chicago 32, Illinois • Cincinnati 13, Ohio • Detroit 28, Michigan • Houston 11, Texas
Los Angeles 22, California • New York 17, N. Y. • Philadelphia 48, Pennsylvania
Pittsburgh 22, Pennsylvania

* Trademark of Union Oil Company of California

What's New!

Controlling Viscometer

. . . can measure, record and control viscosity automatically and continuously; bulletin describes "Ultra-Viscoson" with 15 petroleum and petrochemical processing applications; operates from zero to 50,000 centipoises from —109° to +650° F. with 4 cc sample. Bendix Aviation Corp., Cincinnati Div., 203 W. 3rd, Cincinnati 2, Ohio.

Circle No. **75** *on Reply Card*

Phthalic Anhydride

. . . for resins, solvents, flame resistant plasticizers and other uses; 24-page booklet gives applications, physical and chemical properties, reactions, compatibility with resins and methods of handling. Monsanto Chemical Co., St. Louis 4, Mo.

Circle No. **76** *on Reply Card*

Maintenance Improvement

. . . through planned programs to improve service and reduce costs; booklet *DR-954-5, Get Better Maintenance*, describes services in the measurement of effectiveness, organizing maintenance, and establishing maintenance standards. Anderson-Nichols & Co., 150 Causeway St., Boston 14, Mass.

Circle No. **77** *on Reply Card*

Bayonet Tank Heaters

. . . for minimum installation and maintenance cost: Bulletin No. 3006 describes "Cal-Fin" series BH and BW, with horizontal installation allowing tank fluid levels as low as 2 ft. without exposing heater, gives drawings and specifications. Drayer-Hanson, Inc. Box 2215, Terminal Annex, Los Angeles 54, Calif.

Circle No. **78** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of Petroleum Processing to assist you in obtaining more information on any items received in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item. Then fill in the rest of the card and drop it in the mail. No postage is required.

J-M BLAZECRETE builds longer lasting refractory linings . . .

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

Blazecrete* linings last longer because they resist spalling, withstand slagging action, and are not harmed by rapid temperature changes.

Thus you cut down on refractory maintenance costs—and you save on labor costs, too, because Blazecrete goes on fast. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place. When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete may be applied easily without laborious ramming or tamping.

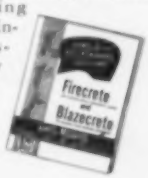
Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix—can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic-setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.



*Reg. U.S. Pat. Off.

Whether you gun it... *or slap-trowel it...*

Johns-Manville BLAZECRETE

BUILDS BETTER REFRACTORY LININGS

(To obtain more data on advertised products see page 108)

Capital Spending Plans for 1955 . . .

Here is Good News About Business Prospects

In 1955, American industry is now planning to spend within 5 per cent of the amount it is spending this year on new plant and equipment. This is the tensely awaited result of a check-up just completed by the McGraw-Hill Department of Economics.

Hundreds of companies, by far the largest number in the eight-year history of these McGraw-Hill surveys, cooperated in the check-up. Combined, they represent 29 per cent of all industrial employment and over 60 per cent of employment in the industries where capital investment is highest. Such a broad cross section constitutes a reliable gauge of the plans of industry as a whole.

PLANS FOR CAPITAL INVESTMENT

	MILLIONS OF DOLLARS			Percent Change 1954-1955
	1953 ACTUAL*	1954 ESTIMATED*	1955 PLANNED	
All Manufacturing	$10,026	$ 9,249	$ 8,598	—7%
Petroleum Industry†	4,600	4,875	4,920	+1
Mining	506	380	311	—18
Railroads	1,312	831	769	—10
Other Transportation and Communications	2,954	2,922	2,640	—10
Electric and Gas Utilities	4,548	4,274	4,206	—2
ALL INDUSTRY	23,271	21,784	20,727	—5

*United States Department of Commerce; Chase National Bank; McGraw-Hill Department of Economics

†Petroleum refining, included under both "All Manufacturing" and "Petroleum Industry," is included only once in the total

What is the meaning of these plans, detailed by the table below, for capital investment next year? Is it good or bad news, so far as it concerns the prospect of continuing prosperity? It is to this crucial question that this editorial is addressed.

Key to Prosperity

It is not only good but very important business news that American industry plans to spend in 1955 almost as much for new plant and equipment as it is spending this year. The reason it is important is that a high level of activity in the capital goods industries is universally recognized as a particularly potent ingredient of prosperity for the nation as a whole. A dollar spent for capital goods is spent again and again for wages and materials. Its stimulating effects, called by economists multiplying effects, move through the economy in much the same way that a pebble tossed into a pond creates a widening circle of ripples. This is one reason why there is such intense business interest in the surveys of plans for capital investment.

Here are the principal reasons why the results of the McGraw-Hill survey are a good omen for continuing prosperity:

1. American industry is demonstrating that it does not need the stimulus of war-created shortages, or a rearmament boom, in order to maintain a very high level of capital investment.

The slight decrease now planned for 1955 will still maintain a level only about 11 percent below the all-time peak attained in 1953 under the stimulus of a defense expansion boom.

2. Capital investment promises not merely to stabilize at a high level, but actually to increase as 1955 goes on and thus give renewed stimulus to business.

The level of investment now planned for 1955 by *industry* — manufacturing, petroleum, mining, transportation, communications and utilities — is within 5 per cent of 1954. Contract awards for *commercial* construction — stores, office buildings, warehouses and other service establishments — as compiled by the McGraw-Hill publication ENGINEERING NEWS-RECORD, indicate a substantial increase in 1955. Thus total capital expenditures by *all business* may be very close to this year's total.

Actually, in the fourth quarter of 1954, business capital expenditures, as reported to the U. S. Department of Commerce, are down about 2.5 per cent from the average for the year as a whole. So there is a good chance that during 1955 the annual rate of capital investment will rise above this present level.

Effect of Tax Changes

The plans reported by the McGraw-Hill survey are preliminary plans, reported at the beginning of the period of business budgeting for 1955. As budgets are completed, new projects may bring the total expenditure that is planned even closer to this year's figure and thus make an even greater contribution to continuing prosperity.

But it also cannot be too strongly emphasized that these are plans; they are not accomplished investments. As such they have the vulnerability to changed conditions that characterize any plans.

There is some indication in the results of the McGraw-Hill check-up that one change in conditions recently made by the United States government has had an important stimulating effect on plans for business investment next year. It is a liberalization of the allowances for depreciation. Apparently encouraged by this provision, most of the smaller companies are planning to maintain or increase their purchases of new equipment next year, whereas during the past three years their expenditures have been declining. This is obviously a development that strengthens our economy.

A government insensitive to the key importance of capital investment by business, both in providing prosperity and in raising our standard of living, might easily destroy the present plans. One of the easiest and surest means to do this is excessive taxation of business profits which are the key ingredient of business investment. Whether the extraordinarily constructive program recently enacted by the federal government in the field of business taxation can be sustained remains to be seen. **If it can be sustained, the remarkably cheering plans of business for capital investment in 1955 can readily become firm foundations for a continuing prosperity.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

EDITORIALS . . .

There Are Still New Worlds Ahead

IF YOU read this page regularly, you will recall that last November we gently chided the petroleum processing industry for being so slow in awakening to the possibilities of applying atomic energy as a processing tool.

Three weeks after that editorial appeared we were invited to a press conference at which Standard Oil Development Co. announced plans for a $250,000 laboratory and a $1-million research program for that very purpose—to find out how to use atomic energy in processing.

We take no credit for our editorial being responsible for SOD's move. Long months of planning obviously preceded their announcement.

But we do commend the management of SOD and the parent Standard of New Jersey for the courage and faith which has led them to invest vast sums in this undertaking. We also suggest that others in our industry re-examine their own research programs in the light of what SOD is doing—which you'll find described in some detail on p. 43 of this issue.

There are still new worlds to be conquered.

It's 25 for the Refining Division

THIS year the Refining Division of API is celebrating its silver anniversary. It was in January 1930 that the institute's directors approved the plan for reorganizing the work of the API into three divisions of refining, marketing and production.

The general reorganization was designed, according to press reports at the time, "to provide adequate departmental organization whereby institute activities may be more actively participated in by the membership and to permit independent consideration of specific problems relating to any division . . ."

W. M. Irish, of Atlantic Refining Co., was the first chairman of the General Committee of the Division of Refining, and its secretary was R. P. Anderson, refinery technologist on the institute staff. The personnel have changed, but the aims of the Division have not. It still exists, in part, to provide a forum for the discussion of non-competitive problems particularly pertinent to a specialized branch of the industry.

We heartily congratulate the Division on the successful and constructive existence it has had during the past 25 years—and we fully expect its activities to be equally praiseworthy during the next 25.

Get Your Figures in, Boys

EARLY this year the Department of Commerce will undertake the 1954 Census of Manufacturers, the first since the 1947 Census. It will cover an estimated 275,000 manufacturing establishments, including those turning out petroleum products and chemicals.

The census is designed to gather basic data on such items as employment, payrolls, hours of work, cost of materials consumed, power equipment, water consumption, value of products shipped, and the like. These facts about your own and similar companies, when all collected together, represent one of the most helpful services which our government performs. They will be used many times during the next several years (perhaps even by yourself) in making decisions on plant expansions and locations, product development, and many other matters.

You may think you never call on the Census Bureau for statistical data. Yet, many of the facts that you get from API and similar associations came originally from the Census reports. These data, which are so important to you, would not be available if you and others in the industry didn't supply the raw material, so to speak, in the first place.

What can you do to help? If you have the responsibility of seeing that the report forms for your plant are properly filled out, or if your boss asks you to supply some of the necessary data, do it completely, accurately and promptly.

The quality of the final census in the long run depends on the quality of the data you supply.

Even Engineers Can Be Threatened

OUR hats are off to the various foundations—the Ford, the Carnegie, and others—in their vigorous stand against the false accusations and half-truths thrown at them in the recent majority report made by the Reece committee of the House of Representatives.

Arguments in political philosophy would seem to have little place in these columns. We hold no particular brief for or against congressional investigating committees as such. However, they do seem to us somewhat in violation of the principles of the republican form of government—though perhaps not yet reaching the police state. These principles provide for three main divisions in the government: executive, legislative, and judicial. And somehow it has always seemed that the job of investigating belonged to the executive arm, with of course control and direction supplied by the legislative and judicial branches.

The point is that—beginning with the famed Truman committee of World War II days—both the Senate and the House have seen fit to establish investigating committees. For the most part, these committees have conducted their work in businesslike and democratic ways—and by democratic we mean to include fair play, hearing out both sides, and sticking to the truth.

It has therefore been a disappointment, and a point well worth taking warning from, that the newest congressional investigators have been no improvement over their predecessors. They have overstepped the bonds of decency. They have used half-truths. They have denied the accused a voice and a chance on the witness stand.

These are tactics American business has had to fight for many a year. Let's hope it has learned to stay on guard and can continue the fight. Big government is more than a "dirty word." Look at Malenkov's Russia, Hitler's Germany, Mussolini's Italy.

For HYDROFLUORIC ACID

Anhydrous or Aqueous

See General Chemical First!

8 Distribution Points

- Baton Rouge, La.
- Buffalo, N. Y.
- Chicago, Ill.
- Cleveland, Ohio
- Edgewater, N. J.
- El Segundo, Calif. (Los Angeles)
- Marcus Hook, Pa. (Philadelphia)
- Pittsburgh, Pa.

To Supply Your "HF" Needs Efficiently Wherever Your Plant May Be . . .

General Chemical has eight strategic distribution points across the country. Located from New York to California, they place stocks of this essential acid only *hours* away from any consuming area!

If you use "HF" in either aqueous or anhydrous forms—in any grade from commercial to reagent—you will find General Chemical geared to serve you well.

Just phone or write your nearest General Chemical office for further information on how our services can be put to work for you.

GC Allied Chemical

Basic Chemicals for American Industry

...FIRST IN FLUORIDES

GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL & DYE CORPORATION

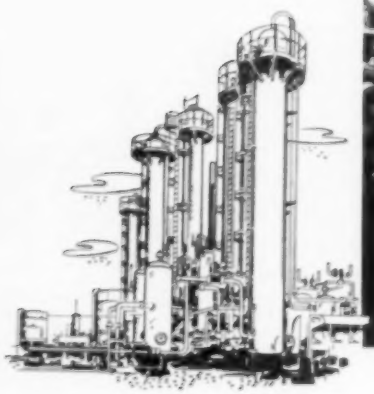
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cleveland • Denver • Detroit • Greenville (Miss.) • Houston • Jacksonville • Kalamazoo • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Providence • San Francisco • Seattle • St. Louis • Yakima (Wash.) • In Wisconsin: General Chemical Company, Inc., Milwaukee

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

wyatt

...will be there



• Just how the Petroleum Industry is going to meet the requirement of doubling its refining capacity in the next twenty years is beyond our calculation.

What we do know is that it will call for Wyatt's shops to keep moving pressure vessels into refining plants the country over, as this one is going into service in the Lake Charles plant of Cities Service Refining Corporation.

wyatt's
HOUSTON · DALLAS · NEW YORK · TULSA

MANUFACTURERS AND ERECTORS SINCE 1913